In this Issue: 84 pages and inset.—Progress of MUNICIPAL OWNERSHIP in the United States.—AMOU DARIA BRIDGE; TRANSCASPIAN RY.—NORTH POWER STATION; St. Louis Electric Railways.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Volume XLVII.
No. 15.

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Vol. XLVII. No. 15.

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TRACK ELEVATION IN CHICAGO will be extended materially under the provisions of an ordinance passed April 2, covering the network of tracks in the territory bounded by 12th, 31st and Halsted Sts. and California Ave. It includes 88½ miles of track, and there will be 28 subways required. The ordinance must be accepted by the railway companies within 90 days and the work must be completed by Dec. 31, 1908. It was proposed to make this a mandatory ordinance, the city's legal advisers having decided that the city has the power to compel the companies to elevate their tracks, but in order to avoid the chance of the companies stopping the matter by legal proceedings, it was decided to adopt the old form of contract ordinance. The railways concerned are as follows:

	Miles.
Chicago, Burlington & Quincy Ry	27.93
Chicago & Northwestern Ry	32.25
Pittsburg, Cincinnati, Chicago & St. Louis Ry	10.15
Chicago Junction Ry	4.45
Chicago Terminal Transfer Ry	12.75
Atchison, Topeka & Santa Fe Ry	1.00
Total	88.53

THE CHICAGO MUNICIPAL OWNERSHIP REFERENdum, on April 1, resulted in 124,190 to 19,007 votes in favor of municipal ownership of gas and electric light plants, and 124,594 to 25,987 for street railways. A referendum vote on the question of direct nomination at primaries, in place of the common party primaries, resulted in a vote of 125,082 for and 15,861 against. It will be noticed that the affirmative vote on each proposition was practically the same, but that there was least opposition to direct primaries, and most of municipal street railways, while gas and electric light plants under city ownership come between. The total vote was light.

THE NEW BERLIN ELECTRIC RAPID TRANSIT Railway, the opening of which to traffic we noted in our issue of Feb. 27, of this year, was finally opened throughout its length on March 25. The line is largely elevated, but has about a mile of subway. Its total length is something over six miles. It is operated in three divisions: from the middle of the main line, which runs from the Zoological Garden to the Stralauer Gate, a spur runs north to the Potsdam Railway Station; the three terminals are connected by three independent traffic routes. The last of these routes began regular operation on March 25, while the first of the three was opened over a month before. A detailed description of this new rapid transit line will appear in our columns in the near future.

THE TRAMWAYS OF HAMBURG, Germany, include 113.5 miles of line, the larger part double track, and only 3.72 miles are operated by horses, the remainder being electric. According to the concession granted for changing to electric traction all the lines and structures connected with them within the limits of the city will revert to the city in 1922. The operating company meanwhile pays to the city treasury 1¼ centimes, or ¼ ct. per passenger carried, 5% upon the tickets sold and a certain percentage of all profits above that required to pay 6% dividends to the stockholders. The fares charged vary from 2½ to 7½ cts., according to distance and class.

THE PASSAIC VALLEY SEWERAGE COMMISSION, authorized by the last session of the legislature of New Jersey, was named by Governor Murphy on April 5. The members are as follows: Messrs. Winston C. Garrison and Francis Child, of Newark; Peter Hauck, of Harrison; Wm. McKenzie, of Arlington, and John Hinchliffe, of Paterson. Mr. Hinchliffe has been a member of the New Jersey State Sewerage Commission for several years, and is also Mayor of Paterson. The Commission will formulate and report to the legislature a plan for preventing the pollution of the Passaic River, together with a draft of a bill to carry the plan into effect. The proposed report will make at least the fifth, including one by a legislative committee, on the Passaic Valley sewage disposal problem. After the report is made the legislature must still pass an act providing for the construction of sewage disposal works and the raising of money for the same.

A WATER POLLUTION SUIT IN NEW JERSEY has resulted in a decision that the Diamond Paper Mills Co., of Rahway, may be enjoined from polluting the Rahway River, even if the water supply of Rahway is not injured thereby. It is sufficient, Vice Chancellor Stevens holds, that the legislature believed such an act would work injury, and not necessary to prove that injury has been caused. The suit was brought by the State Board of Health, under an act of 1899, designed to protect public water supplies.

EUROPEAN SEWAGE DISPOSAL METHODS are to be studied, it is reported, by a chemist, and the expenses of the necessary trip, up to $2,000, paid by the Province of Ontario.

THE PITTSBURG WATER FILTRATION BIDS, received on Feb. 24, are given in detail in the Supplement to this issue. As previously announced, no contract will be awarded under these bids, owing to an injunction declaring that plans and estimates for the whole plant must be made before any contracts are let. Nevertheless the bids, having been made in good faith, are valuable as records of prevailing prices, at the date named, for this class of work. Mr. Morris Knowles, Assoc. M. Am. Soc. C. E., is Resident Engineer for the filtration work.

THE VIRTUAL TRANSFER OF THE JERSEY CITY water contract to the East Jersey Water Co. has been formally executed and a contract to that effect signed by Jersey City, the Jersey City Water Supply Co., and the East Jersey Water Co. The time for completing the works has been extended from February of the present year until Dec. 25, 1903.

THE GRAND RAPIDS WATER-WORKS deal has resulted in the imprisonment of several men, as already noted, and in a fine of $2,000 for the young New York capitalist who supplied the money to "put through" the big contract for a new water supply from Lake Michigan.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Allegheny Valley Division of the Pennsylvania R. R. on April 4. About 20 miles out from Pittsburg a freight train was wrecked by a landslide. Two men of the train crew were killed.——On April 9, a fast passenger train on the Cleveland, Cincinnati, Chicago & St. Louis Ry. was wrecked by a washout between Cleveland and Indianapolis. Two men of the train crew were killed, but none of the passengers were hurt.

A FIRE IN A CONCRETE-STEEL FACTORY building occurred on the night of April 7 at the plant of the Pacific Coast Borax Co., at Constable Hook, N. J. The building is four stories high, about 60 × 150 ft. in plan, and has exterior walls, floors, and columns all built of concrete reinforced with steel by the Ransome system. A wooden elevator shaft served to carry the fire; the roof, which was of wood, was entirely burned, and the elevator shaft enclosure, some wooden stairways and other woodwork were also consumed. The contents of the building furnished little food for the fire, which at no time could have been called a "hot fire." The walls, floors and columns suffered no damage from the fire; the floors had a panel broken through at one or two points, where heavy loads fell upon them, and some of the beams were cracked. With such exceptions the structural part of the building appears to have been entirely unaffected.

A WATER TANK FAILED at Montgomery, W. Va., on April 5. It appears that the tank was of wood and had just been completed for the Montgomery Water Co. The failure is said to have originated in the bands.

A BRIDGE WAS WRECKED BY DYNAMITE at Whiteport, N. Y., on April 1, 1902. The bridge, which crossed a small creek and two highways, was owned by the Consolidated Rosendale Cement Co., and served for the transportation of finished material from the mill on small horse-drawn cars. It was a three-span structure of wrought-iron, about 240 ft. long, with Pratt trusses projecting a few feet above the roadway. It was built in 1877 by the New York Bridge Co. The wrecking was evidently done with malicious intent. Several sticks of dynamite were placed upon one of the intermediate piers between the end posts of the two adjacent spans and were set off at about 10 p. m. on the date referred to. The explosion forced apart the two spans and completely wrecked their end panels, so that these spans fell to the ground. One of the end posts was literally torn to ribbons, the other was crushed out of shape, and the cast bed-plates were blown to atoms; the remaining panels of the bridge were practically unhurt, and the top of the pier, curiously enough, was little damaged. The material showed at the fractures to be of generally good quality. The repair of the bridge was at once taken in hand, the work being done by Snare & Triest, of New York city.

WET AND DRY CONCRETE was discussed at the April meeting of the Western Society of Engineers. Mr. H. W. Parkhurst, Engineer of Bridges and Buildings of the Illinois Central R. R., presented a paper on "Wet, Dry and Medium Concrete," describing the results of experiments made by him with concrete blocks, the experiments being somewhat similar to those described in our issue of March 28, 1901. His general conclusions were as follows:

(1) A medium concrete, or one that has not enough surplus water to produce quaking, while having enough to permit easy and thorough ramming, is most desirable. The specification that the concrete shall not quake in the barrow, nor while handling, but that it may be wet enough to quake when heavily rammed, would seem about right for regulating the amount of water to be used.

(2) It is probably safer to have an excess than to permit a deficiency of water. Above all, however, it is of the utmost importance that the concrete shall be consolidated thoroughly by ramming.

Mr. Parkhurst explained that the requirement that the concrete shall be dry enough so that it will only quake under heavy ramming is definite enough to be understood by the concrete mixing gangs. To make it still drier would involve difficulty in properly gaging the water, and the practical conditions of concrete making must be taken into account in preparing specifications. The men are, as a rule, liable to mix concrete too wet, as it is easier to handle, to deposit and to ram; but with very wet concrete much is often lost by being spilled from the wheelbarrows. Mr. W. H. Finley, Principal Assistant Engineer of the Chicago & Northwestern Ry., referred to the necessity of using a wet concrete in packing contracted spaces, between timbers, etc. Mr. E. E. R. Tratman, Associate Editor of Engineering News, thought the gist of the matter lay in the last sentence of Mr. Parkhurst's conclusions, as neither very wet nor very dry concrete can be properly rammed. If too wet, the ramming will tend to separate the ingredients, while if too dry, no reasonable amount of ramming will fill the voids with mortar so as to make a solid mass.

A LOADING TEST was recently made of an Ingoldsby automatic dump car, built for the Colorado & Wyoming Ry. The car was of wooden construction, similar to that described in Engineering News of July 11, 1901, and was designed to carry a load of 110,000 lbs. As turned out of the shops the car had a camber of ¾-in. on one side truss and 1⅛ins. on the opposite side truss, while the center member had a camber of 1 in. The car was then loaded with pig-iron, car wheels and car axles, the loads being successively 96,320 lbs., 145,000 lbs., 151,000 lbs., and 160,600 lbs. After each of these loads was applied the car was run over rough yard tracks, frogs and switches and subjected to heavy buffing strains. The total deflection under this loading and service was 1⅛ ins. and 1¾ ins. on the side trusses and 1⅜ ins. on the center member. When the car was emptied, the side trusses returned to a camber of ½-in. on the side which had an original camber of 1⅛ ins. and to a camber of ¼-in. on the side which had an original camber of ¾-in. Some weeks later the same car was loaded with 235,000 lbs. of wet iron ore and the load was dumped by hand by one man in less than one minute. The principal dimensions of this car are as follows:

Height from top of rail to top of car body proper	8 ft. 4 ins.
Width over all	10 " 0 "
Length over end sills	41 " 9 "
Height of false top	20 "
Weight of empty car	39,400 lbs.

A TRAIN TELEPHONE has been installed on the Overland Limited train of the Chicago & Northwestern R. R. Co. This train runs from Chicago to San Francisco in 2 days, 21 hours, 25 minutes, and is said to be the fastest long-distance train in the world. The telephone is connected to the central office of any city or town stopped at by means of a cable attached to a tripod in the roof of the car carrying the instrument. An operator at the station is detailed to make this connection as soon as the train stops, and the operator on the car is then in connection with the local "central." It is the company's purpose to extend this telephonic connection throughout the several cars of the train.

THE NEW BRIDGE OVER THE AMOU DARIA RIVER ON THE TRANS-CASPIAN RAILWAY.

By A. Zdziarski.*

The Trans-Caspian Railway, in its extension from the Caspian Sea to Samarkand, reached the Amou Daria River, near Chardjoui, in 1887, and a temporary wooden bridge was built across that stream for the transportation of railway material. A steam ferry had been previously established at this crossing, but this was altogether insufficient for the purpose proposed. The project for the wooden bridge was suggested by Gen. Komarsov, approved by Gen. Rosenback, the Governor-General of Turkestan, and the structure itself was soon built under the energetic constructors of the new railway, Gen. M. Annenkoff and Prince Hilkoff; the latter is now the Russian Minister of Ways of Communication.

The contract for building the wooden bridge was let to Mr. J. Balinski, working under Capt. D.

Fig. 1. Sketch Map Showing Extent of Trans-Caspian Railway System and Location of Amou Daria Bridge.

Chorwat, now Superintendent of the Middle Asiatic Railway. Work was commenced on Sept. 13, 1887, and the trains crossed the completed structure on Jan. 19, 1888. The actual cost of the bridge was somewhat less than the estimated cost of transporting the construction material for the railway extension by the steam ferry, to say nothing of the availability of the bridge afterwards for the regular traffic of the Samarkand Railway.

The bridge built was of the ordinary trestle type, and it was originally constructed in two separate parts, 5,677 ft. and 560 ft. long, respectively. These two parts were connected by an earth embankment 2,177 ft. long; but in 1889 and in 1900 floods began to wash away this embankment, and a wooden trestle was substituted for it, resulting in a continuous wooden structure, 8,694 ft. long. This wooden bridge is still in existence—in 1901; but during these 13 years it has been partially destroyed by the floods and ice a number of times, causing serious interruption to traffic. The bridge was sometimes broken for many months at a time, and goods and passengers were then carried over by means of the local boats, or "kaiouks." This ferriage was difficult and expensive, as the velocity of the current sometimes reached 13 ft. per second, and the channels were constantly shifting. In addition to this delay by the destruction of parts of the bridge, the annual cost of repairing and renewing this wooden structure was about $25,000.

In the beginning of 1895 the bridge was so damaged by running ice that traffic was stopped for two months. In this same year a commencement was made in the extension of the railway from Samarkand to Audijan, with a branch to Tashkent. The demand for the transport of material was urgent, and the Minister of War, Gen. Wannowski, advised the construction of a permanent bridge over the Amou Daria; this recommendation was approved by the Emperor on April 6, 1895, and the money necessary was appropriated. Surveys and plans were commenced under Gen. Tasinkowicz, of the Military Engineers; but as no satisfactory progress had been made at the end of 2½ years, the Council of State, in 1897, turned the construction of this bridge over to the Ministry of Ways of Communication.

In May, 1898, a board of construction was organized and at once commenced new surveys; and experiments with the sinking of two cylinder piers by the method of open dredging. This latter work was performed in November and December of 1898, and gave satisfactory results. The surveys covered an area extending 13.3 miles above and 2 miles below the site of the proposed bridge.

The design for the bridge was approved in the spring of 1899 by the Engineering Council of the Ministry of Ways of Communication; and the estimates of cost, approved by the Council of State, amounted to $2,416,500. In this estimate the bridge proper was to cost $1,734,000; the cost being much reduced by reason of the adoption of the open dredging system and the omission of ice-breakers on the piers.

The Board of Construction appointed S. Olszewski, C. E., as Superintendent, and his assistants were Messrs. Kikodze and Kharitoner, civil engigineers. The surveys gave the following general results:

On Nov. 7, 1898, the water level of the river was 724 ft. above the level of the Caspian Sea. The clear width of the river was 3,500 ft.; the cross-sectional area was 9,784 sq. ft.; the mean velocity of the current per second was 3.15 ft.; the discharge per second was 32,777 cu. ft.

On July 5, 1898, with the river 728.5 ft. above the level of the Caspian, the clear width of the river was 6,132 ft.; the cross-section was 50,694 sq ft; the mean velocity was 5.11 ft., and the discharge per second was 281,202 cu. ft. From the above data a discharge was calculated for a water level of 729.75 ft. above the Caspian, or 405,626 cu. ft. per second. The maximum depth of the river was 45 ft., and the mean slope was 0.00024.

As the current tended to wash away the shore next to the town of Chardjoui, and at other points, measures had to be taken to protect these banks; and about 385 ft. below the bridge it was necessary to construct a temporary harbor—with a railway connection—for loading the bridge material, which latter was carried to the bridge in native boats. The shores were protected by brush mattresses sunk with stone at high water.

The falseworks for Pier 9 were put in place in August, 1898; on Oct. 29, the first cylinders were sunk; and the results of the trial proved so satisfactory that the plan of open-dredging was adopted for all the piers. The new bridge was designed to accommodate the traffic of the Mid-Asian railway system only. It is a single-track structure, 18 ft. wide in the clear between trusses, with a 4-ft. footway carried on cantilevers projecting from the upstream side. The new bridge is 5,250 ft. long, or 5,618.9 ft. long from back to back of the abutment masonry. It consists of 25 through spans of 210 ft. clear opening; two abutments and 24 piers, each made of two riveted cylinders. The bottom chord is 21 ft. above extreme high water, and the base of the rail is 25.55 ft. above the same level. The material through which the pier columns are sunk consists of quicksand and clay and sand mixed, and they rest either upon a cemented grey sand or a red clay stratum. The depth of these foundations varies from 77 to 84 ft. below high water level. The floor system is metal; and the bridge rails are provided with compensating apparatus, guard-rails and "guard-aprons" on the approaches near the abutments. On the Chardjoui shore the approach embankment crosses an irrigating canal by a 35-ft. girder span, on masonry abutments.

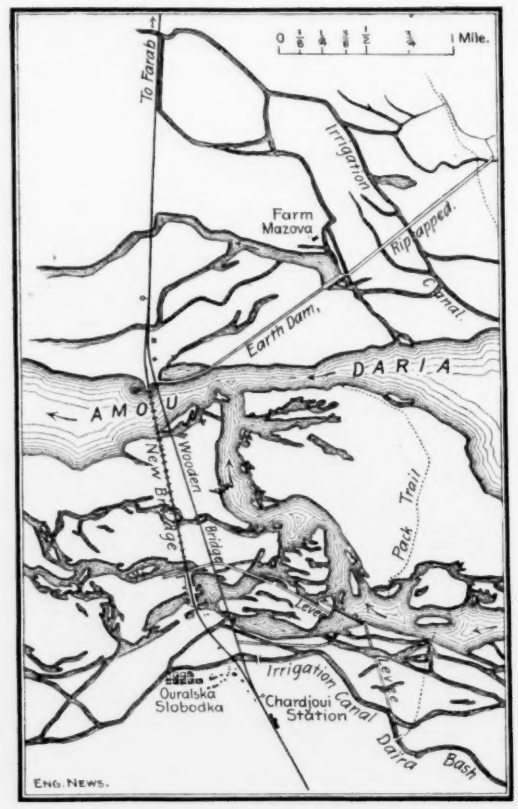


Fig. 2. Map of the Amou Daria River, at Chardjoui; Showing Location of the Old Wooden Bridge and the New Bridge, and Proposed Dike System for River Regulation.

The abutments to this bridge were made up of a pier, retaining wall and a connecting wall, and these were all located in one open caisson, which was sunk by dredging from eight iron shafts passing through the bottom of the caisson; compressed air was not used. The special dredging scoops employed had two plate-iron blades, ¾-in. thick, so connected by chains that they opened when descending; and dug in and closed on the ground automatically in hoisting. Under ordinary conditions, with three 8-hour shifts per day, the average work of each excavator was 1,372 cu. ft. in 24 hours; about 13.75 cu. ft. being lifted each time. As the material was dredged out of the wells, the caisson and shafts were built up with new steel plates as the abutment sunk. Work was stopped with the bottom of the abutment caisson 80.5 ft. below high water and resting upon the clay. The shafts were then sealed with concrete, and concrete was also deposited on the floor of the caisson by means of boxes with hinged bottoms. On a common masonry foundation in this caisson the retaining walls and pier were built in the dry. These two abutments were commenced on June

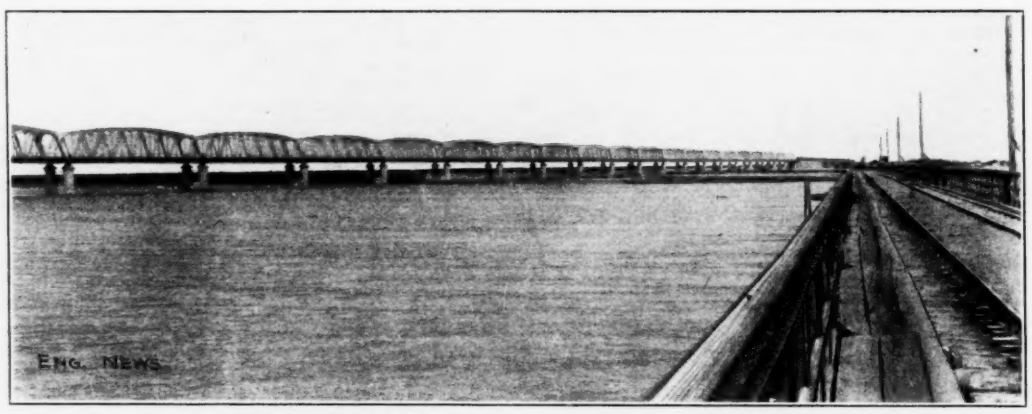


FIG. 3. GENERAL VIEW OF OLD AND NEW BRIDGE.

*Engineer in Department of Ways of Communication, St. Petersburg, Russia.

15, and on Sept. 10, 1900, respectively, and the masonry work was completed on Oct. 27 and Dec. 27, of the same year.

Each of the 24 piers consisted of two columns each 8.68 ft. in diameter in the upper section, and 12.04 ft. in the lower part, and made of riveted

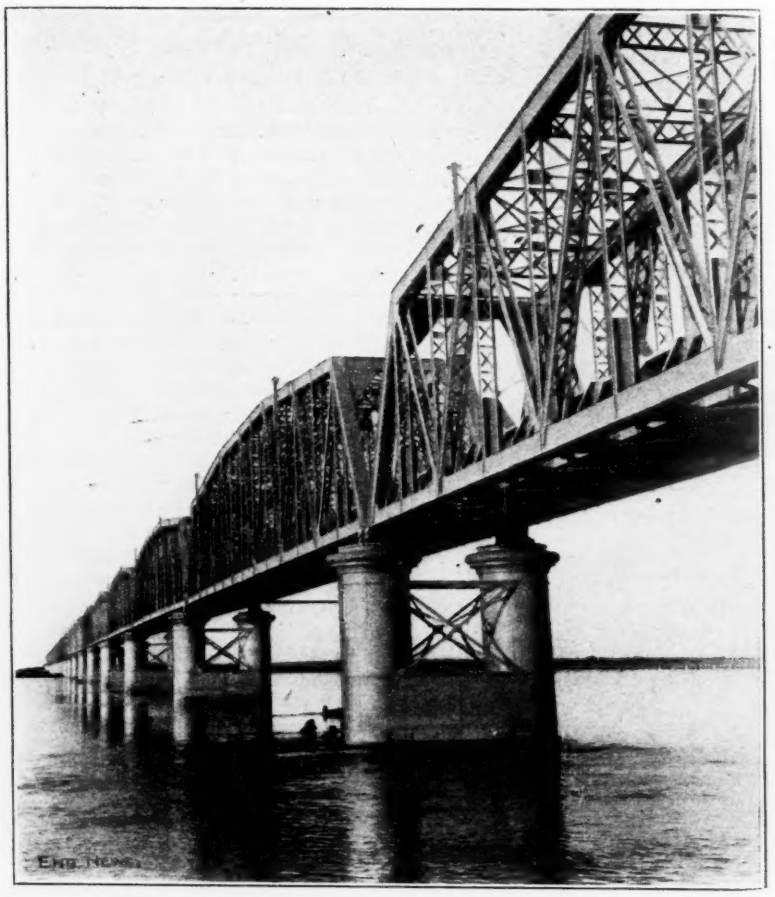


FIG. 4. VIEW UNDERNEATH NEW BRIDGE, SHOWING PIER CONSTRUCTION.

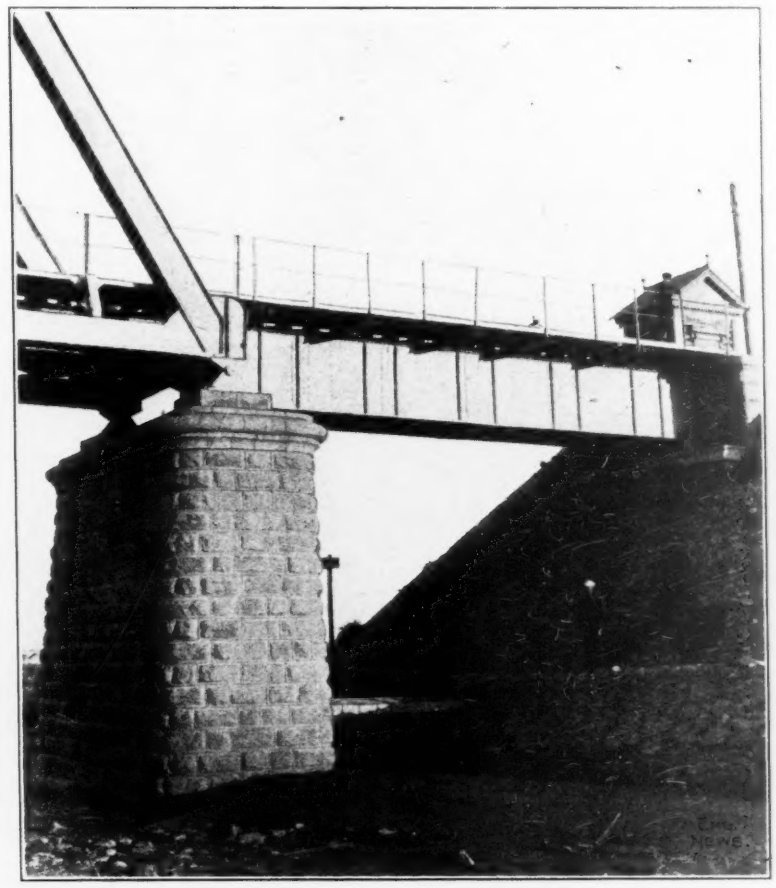


FIG 5. THE CHARDJOUI APPROACH ABUTMENT.

¼-in. steel plates. These columns were sunk 18.2 ft. apart on centers; and the clear opening between the piers was 212.31 ft. The top of the coping-stones, carrying the trusses, was 19.18 ft. above the theoretical high-water level adopted, and each column was sunk an average distance of 77 ft. below this level, with the cutting edge in all cases in the clay; the total average height of each column, from cutting edge to the top of coping is thus 97 ft. Each pair of columns is connected, at the level of the river bottom, by a solid iron ring; and just above low water line they are enclosed in a shell made of ¾-in. steel plates, 12 ft. high. Above this shell the columns are connected by diagonals; and an angle-iron ring again connects them on the line of the caps surrounding each column. These cylinder piers were sunk by means of excavators and open dredging; and weighted by a rubble masonry ring built inside the steel shell as it sunk. When sunk to the clay each cylinder was filled with concrete to low water level. At this point a new set of ½-in. steel shell-plates was started inside the other, and connected to angles embedded in the concrete, and formed the smaller diameter cylinder referred to. This last cylinder was also filled with concrete to a considerable height and then finished in rubble masonry. The work of sinking the first pier was commenced on Oct. 29, 1898, and the masonry of the last one was completed on June 13, 1900.

All of this foundation and pier and abutment work was carried out under the day's-work system, under the direction of the Board of Construction. (While the author does not distinctly say so, it appears that the abutment caissons and the piers were suspended by linked steel members during the sinking operation; as is shown by photographs, in the case of the abutments, and is inferred from the text of the author in the case of the piers.—Ed.)

The superstructure of the Amou Daria bridge consists of 25 through spans; each span made up of riveted members, with a curved top-chord and inclined end-posts. The clearance between trusses and posts are latticed angles and channels, with riveted connections. The track is supported by transverse girders, carrying longitudinal track stringers and steel crossties on corrugated iron plates. On the upstream side of each truss a 4-ft. footway is carried on cantilevers and floored with wood. At 26 points in the length of the bridge provision is made for storing water-barrels and fire-extinguishing apparatus. Guard rails are placed on each side of the track rails, one foot distant from the latter rails. One end of each truss is rigidly fastened to the pier, while the other end rests upon a nest of five steel rollers; and at the expansion ends the track rails have a regulating device attached.

The bottom chord of the bridge is 21 ft. above high water in the river, giving a sufficient clear height for the passage beneath of the largest steamers on the Amou Daria; all of these steamers being fitted with hinged smokestacks. Telephones are placed in three special boxes on the bridge, and the entire structure is lighted by 52 incandescent electric lights of 25 candle-power each. For this purpose an electric light station is located on the Chardjoui approach. The superstructure of this bridge was designed by Prof. N. Belelubski, of St. Petersburg.

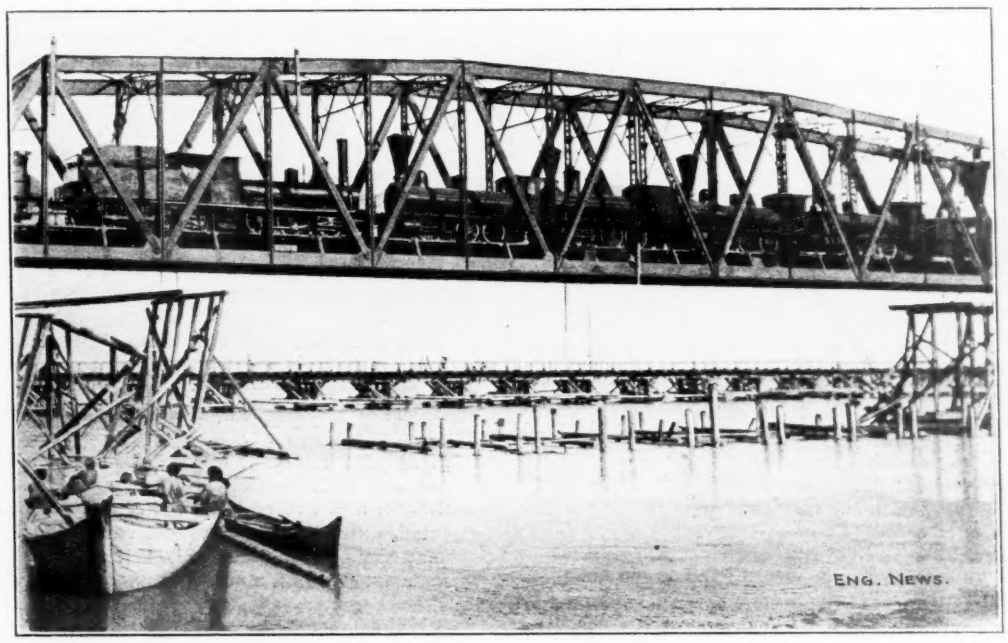


FIG. 7. TESTING THE NEW BRIDGE WITH A STATIC LOAD OF FIVE LOCOMOTIVES COUPLED.

The metal work was erected on ordinary falseworks; though a pile foundation was necessary for 15 of the spans. Traveling cranes were employed in handling the members, and the time consumed in erecting and riveting one span varied

from six to nine weeks. The erection was done by the Briansk Co., under N. Mashin, C. E., engineer in charge. The material used in the trusses was mild steel, from the Alexandrovsk, South Russian and the Briansk works.

The bridge was tested after completion by a special commission appointed by the Minister of Ways of Communication, and presided over by Prof. Belelubski. For the static test of each span two trains were used, each made up of five locomotives in the middle and two tenders at each end. For testing the dynamic load, a train was made up of ten locomotives, each with its own tender, and with the two forward engines alone under steam. This test-train was run over the bridge in one direction at the rate of 18 miles per hour, and back again at a 10-mile rate. By means of slates fastened to the floor girders, and pencils fastened to a pile driven in the river bottom, the deflection of the trusses under load was measured.

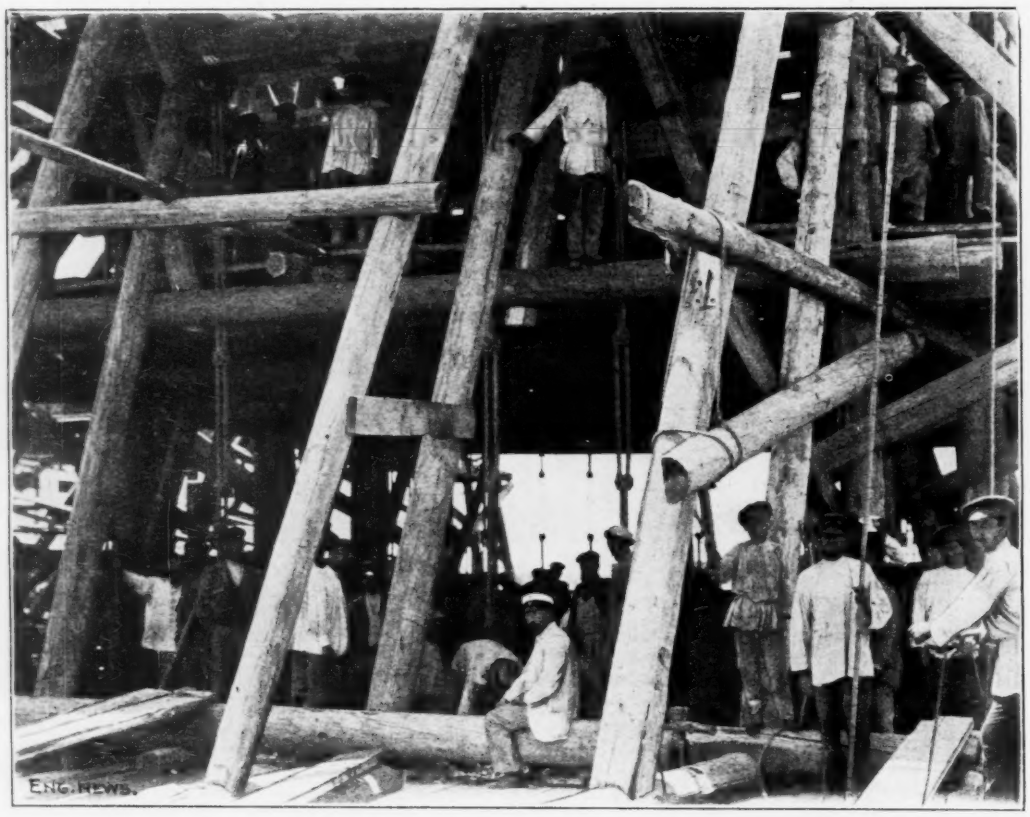


FIG. 6. SINKING THE CAISSON FOR THE FARAB ABUTMENT.

In a length of 210 ft. the permanent deflection was found to be ¼-in.; and the elastic deflection from both static and dynamic load was 1.09 ins.; there was a lateral oscillation of 0.168-in. Further deflection tests were made by the Frenkel-Leiner apparatus, and stresses in the members were measured by the Mahet-Rabut apparatus; all of these tests were satisfactory.

The total weight of mild steel used in the structure was as follows:

	Poods.	Poods.
In the open caissons	24,500	
In the cylinder piers	91,500	116,000
In trusses and floor system	353,500	
In extra floor system	500	
In Baira Dash approach	600	356,500
Total metal work		472,500

As a Russian pood is equivalent to 36.112 lbs., the total weight of metal in this bridge was 17,062,920 lbs.

The earthen approach embankments presented some difficulty, as they were very long, and were made in a considerable depth of water. The approach on the Chardjoui side was 4,144 ft. long, and that on the Farab shore was 7,196 ft. long; and on both sides the grade was 0.8%. These embankments were founded on mattresses of brush sunk with stone, laid in two lines under the outer edges of the slopes; and the space between was then filled with earth.

The very erratic course of the Amou Daria River, with its many small side channels and islands, is shown on the map here given. On the Chardjoui side considerable preliminary work was necessary before the approach could be built; and a bank, 1,260 ft. long, had to be made to connect the old shore-line and the abutment. In this case the whole width of the foundation for the bank was covered with mattresses weighted down by stone; and then across the river, commencing at both sides, mattresses 28 ft. long were sunk one after the other until the low-water level was reached. This method was successful at first; but when the depth of water reached 42 ft., and the velocity of the stream was 20 ft. per second, the sinking of mattresses was abandoned and large stone were thrown overboard from boats instead; when finished there was a difference of 3½ to 4 ft. in the water level on the two sides of the bank. Another bank of a similar kind, and parallel to the first, was built on the downstream side of the approach. With these two banks built, and the top of one covered with earth, a temporary track was laid and the embankment was then made by dumping sand from trains. This approach was 18.2 ft. wide on top, had a 1 on 1½ slope on the upstream side, and a slope of 1 on 1¾ downstream. It contained 140,000 cu. yds. of material. The surface of the slope, to 3½ ft. above high-water mark, was protected by a paving of large stone on a layer of small material about 1 ft. thick. Above the paving a layer of clay protects the sand in the embankment against the fierce wind.

Along these approaches a berm, 10.14 ft. wide, is built on the upstream side. The slope above this berm is planted with white acacia trees and the local elm, or karagach; and in the shallows along the bank, willows are planted. To protect the bank against washing, dykes of fascines and stones are built between the old shore and the abutment; and two training dykes were also constructed, extending 840 ft. upstream and 490 ft. downstream. The approach on the Faral shore was constructed in a similar manner, and contains 38,000 cu. yds. of sand.

To protect the shores against damage by the current an extensive system of training dykes and cross-dykes was found to be necessary; made like the others, of fascines and stone. The bottom of the river is also protected against scour by means of mats 3 to 4 ins. thick, made of grass and sunk by stones; these mats extend out about 35 ft. from the foot of the banks.

The Chardjoui approach crosses a small irrigating canal—the Daira-Bash; and here is a girder bridge 35 ft. long, with the opening fitted with sluice gates. The foundation for both ends of this bridge were made by enclosing the common space in sheet piling and then sinking 24 concrete columns, each 5.11 ft. in diameter and 9.24 ft. high. Upon these columns was placed a layer of concrete 2.8 ft. thick, and on this concrete the ordinary masonry was laid.

EXPERTS' REPORT UPON THE CONDUCT OF DRAINAGE CONSTRUCTION IN NEW ORLEANS, LA.

There has been recently some bitter public criticism of the method of conducting the drainage work in New Orleans, under the charge of Chief Engineer B. M. Harrod, Past-President of the American Society of Civil Engineers. It was charged that the plans and specifications of 1895 had been departed from, and that, as a consequence, the work done and being done was lacking in both stability and efficiency. As an outcome of these charges, Mr. Harrod resigned his position and demanded an investigation and an expert report upon the work done under his professional control. The Drainage Board of New Orleans appointed on this board of experts Mr. Rudolph Hering, of New York; Mr. G. H. Bensenberg, of Milwaukee, and Mr. H. A. Carson, of Boston, all Members of the American Society of Civil Engineers; and this board has now made its report, after a thorough inspection of the drainage work, plans, etc., and the examination of witnesses.

The report of this board is an unqualified endorsement, not only of the thoroughness and efficiency of the drainage work as far as executed, but it approves of the course pursued by the Drainage Board and Mr. Harrod as its Engineer in the various departures from the original plans and specifications. As Mr. Hering had a large part in preparing these original plans and specifications and has been intimately connected with the subsequent progress of the work as a consulting engineer, his commendation of the changes made has the greater weight.

The experts first express their disappointment at the refusal of Mr. L. W. Brown, M. Am. Soc. C. E., Chief Engineer of the construction company, to appear before them and to give them the benefit of his intimate connection with the work. As he had repeatedly publicly condemned the work and prophesied failure as a result of departure from the old plans, and was in a position to point out the various ways in which these plans were changed, the experts believed that his testimony would have facilitated their investigation.

The report takes up in detail the changes in location and alinement, and after carefully examining into the propriety of making each one of these alterations the board finds that all were made in the interest of increased efficiency or economy, without in any way impairing the usefulness of the drainage system as a whole or in its parts. As to changes in dimensions, the statement is made that the original Advisory Board had to base its plans upon information regarding rainfall and run-off that was somewhat meager, and in cases did not extend over the observations of one year. It was understood that observations were to be continued to thus enable the Drainage Commission to make such adjustments in the sizes of drains and canals as wider knowledge might suggest. The experience thus far gained indicates that the drains as built have ample capacity. The construction of the St. Louis St. canal, the first built of the series of large canals, revealed difficulties caused by the nature of the soil and narrowness of the street that made it advisable to reduce its width. But this reduction of the original section had been approved by the original members of the Advisory Board's engineering committee, as it was clear to this committee that the reduced width would be sufficient for years to come, and that it would be practicable to supplement this canal, when necessary, by a parallel canal on another street. In referring to all the changes of dimensions made, the experts find that the course pursued by the board was proper and in the interest of efficiency and economy.

The change in pumping stations—from a set of boilers and pumps at each station to a single cen-

tral station—is found to be in the direction of similar concentration everywhere taking place in the industrial world, and to the obvious advantage of operation. The experts believe that Mr. Harrod's estimated saving of $20,000 per annum from this source in the near future is a reasonable estimate. It is admitted that there are certain risks in this concentration, as the break in wires, etc., and the experts recommend that a reasonable safeguard should be provided against such an emergency by the erection of an auxiliary electric power station at one of the pumping plants designated.

The character of the work done has been carefully examined. The experts found the brick, sand, cement and other materials used to be of excellent character; though as very hard and dense brick are not made within a reasonable distance of the city, those used were not so hard as are employed in some distant cities. One departure from the original plan was the use of monolithic concrete slabs, with corrugated steel rods imbedded near the lower surface, for the covering of drains. But this ferro-concrete, when made of proper materials, was found to be a marked improvement on the old plan; it lessened the cost of such covering and the chance of oxidation of the steel members. The experts found the construction work, as a whole, to be of excellent character.

One of the chief charges made against Chief Engineer Harrod was that he had permitted the use of a cement not named in the original specifications, viz.: Steel Portland, or a Puzzolan slag cement, in place of imported Portland and natural cement. This portion of the experts' official report is so generally interesting that it is published in full, as follows:

In examining and comparing specifications, we noted the use of cement not mentioned in the original specifications, viz.: Steel Portland cement. This is in reality a Puzzolan slag cement. The cements mentioned in the original specifications were imported Portland and natural cement. Each of these three cements is composed in different proportions of lime, silica, alumina and other elements.

In Portland cement the various ingredients are intimately mixed together in fine particles, are burned to a clinker and the latter is finely ground.

Puzzolan slag cement is made by intimately grinding and mixing together suitable blast furnace slag with slaked lime, no burning being required after mixing.

The slag cement used on your work bore the commercial name already mentioned of "Steel Portland." We have tested this cement to some extent in other parts of the country, and found it stronger than some brands of Portland, but not quite so strong as some of the highest grades of Portland. Our own tests were not sufficiently extensive to enable us to positively assign its true rank.

Puzzolan slag cement is used in various parts of the world by engineers of the highest standing. For instance, much has been used within two or three years in the tunnel in Paris for the prolongation of the Orleans Railroad.

The testimony of Prof. Creighton and others is very positive that the so-called Steel Portland furnished here was better than most of the imported Portland cements which were offered and passed under the original specifications.

According to the testimony of Prof. Creighton, of Mr. A. C. Bell and of Mr. W. T. Hardee, these engineers are unanimous in the opinion, based on their own experience, that the steel cement is of especial value, and therefore desirable where used in connection with work that is constantly subjected to dampness.

The original specifications for this work called for the best imported Portland, and gave certain physical tests, which under ordinary usage would serve to fix the quality required. These tests, although substantially the same as those used by many eminent engineers, including officers of the United States Corps of Engineers, were in the light of our present knowledge imperfect and unsatisfactory. They permitted very coarsely ground cements to be used, while it is believed that only the very fine particles have a cementitious value; the tensile tests were applied only to neat cement, although tests which include sand are much more valuable.

In the light of present knowledge, these specifications were defective also in other particulars. The new cement specifications, drawn up by Major Harrod in consultation with Prof. Creighton, avoided all the defects alluded to above and were of a scientific character. There is no doubt that they very materially raised the standard of the cement above that of the original specifications for imported Portland cement, and that they thereby secured a higher grade of cement, even though it was not imported, than that which could have been supplied under the original specifications.

We deem this change in the original specifications for cement, therefore, to have been very desirable, and one beneficial to the character of the work, as it elevated the general requirements of cement.

We compared on your work very carefully the concrete and mortar in which slag cement was used with that in which true Portland was employed, and were unable to determine which was the better. Both appeared to be hard, good and satisfactory.

Natural cement is made by burning and then grinding a rock containing the necessary constituents. American natural cement has much less strength than either Portland or slag cement. It is, nevertheless, used in enormous quantities in all parts of the country and on many underground conduits and tunnels.

In examining the joints in the brick walls of your canals and drains, we found the natural cement mortar less hard than that made with either the Portland or slag cement. The former could be to some extent removed with a sharp steel blade; the latter could not; nevertheless, the natural cement appeared to have fully answered its purpose. We discovered no joints that had been washed out or had deteriorated.

It appears by comparison with the original specifications and the engineer's estimates of completed work that the proportion of natural cement originally contemplated has been materially reduced and that slag or Portland cement of superior strength has been substituted therefor. This departure from the original plans is, of course, also an improvement.

It should be noted here that the use of true Portland cement (of American manufacture), superior in quality both to the imported Portland used on your first contract as well as to the Puzzolan slag cement, has been required on the most recent work. We deem this a further improvement.

The board concluded its report by recommending constant attention to the cleaning and flushing of the drains and canals and the removal of all obstructing rods or pipe-ends. The reason given for this recommendation rests on the fact that these structures are not designed as sewers, and the retention of any sewage in the sand and silt naturally entering from the street surface is liable to cause odors at the street inlets. The experts find that the cost of the system has not differed materially from the estimates of the Advisory Board in 1895, and about one-half of the system has actually been built for less than one-half of the estimated cost.

THE END OF THE GREAT BETHLEHEM STEAM HAMMER.

Many of our readers will remember at the Columbian Exposition at Chicago in 1893 the full-size reproduction of a 125-ton steam hammer which had been erected during the preceding year at the works of the Bethlehem Steel Co., at South Bethlehem, Pa. This huge forging tool, the largest steam hammer in the world, and the samples of the work produced by it, were the wonder and admiration, particularly of the foreign forging experts and ordnance men.

For six or seven years, however, this great appliance has been standing idle, and a short time ago work on its demolition and removal was begun.

After the hammer was built, as part of a large plant for producing the heaviest class of steel forgings, there were put up in the same building some large hydraulic presses. In the subsequent competition between the two types of machines, however, the presses have come out ahead. It was found that in the forging of large masses of metal by blows from a hammer, even though the ram weighed 125 tons, some undesirable effects were produced. As a definite amount of time is required for the molecules of the metal to flow, the action of the blow was so rapid that the compression could not distribute itself uniformly through the mass; as a result the outside of the forging was worked and stretched while the inside remained practically unchanged. Internal stresses were thus set up, and there was a tendency for the formation of flaws in the interior. Especially was this true of shafts for steam engines, which were one of the important products of the great forging plant. With the press, on the other hand, the force is applied slowly and is as strong at the end of the stroke as at the beginning, so that a forging is made absolutely homogeneous, the interior of the piece being as thoroughly and effectively worked as the exterior. Besides this, the press is a more convenient tool to operate and maintain than the hammer.

At the time of its construction the Bethlehem hammer was by far the largest and heaviest in the world, and we believe it has never been surpassed in this respect. Briefly described, it was a vertical single-acting steam engine, with a heavy ram attached to the piston rod. Steam admitted below the piston raised the ram, and its fall produced the desired blow. The accompanying cut is a view of the model, above referred to, which was exhibited at the Columbian Exposition. The steam cylinder had a bore of 76 ins., and the piston had a normal stroke of about 16 ft., which could be increased to nearly 20 ft. The total weight of the moving mass, piston, piston-rod and ram, was 125 tons. The working steam-pressure was 120 lbs. per sq. in. The hammer stood about 90 ft. high above the ground, and measured 38 ft. across at its base.

The 125-Ton Steam Hammer Now Being Demolished.
Bethlehem Steel Co., South Bethlehem, Pa.

AN EXPERT OPINION ON COMPETITION BETWEEN WIRELESS TELEGRAPHY AND OCEAN CABLES.

The achievements of the past few years in making it possible for us to communicate over long distances by means of free electric waves in the ether, have, as might be expected, given rise to many over-sanguine ideas concerning the new art.

At a meeting of the Marconi Wireless Telegraph Co., held in London during February, Mr. Marconi asserted that his system had developed to a complete commercial point as regards both reliability and secrecy of transmission, and that at present it was only a mechanical matter of arranging the necessary installations to enable him to commence regular commercial operation, in any amount, at distances up to the width of the Atlantic. Incidentally, he referred to the comments of the technical press on his work; that of America had given him uniform sympathy and encouragement, but numerous British technical journals were apparently "vowed to the exclusive support of cable interests." This portion of his remarks was taken by our London contemporary, "The Electrician," as directed in part against itself, in view of the fact that it had on different occasions editorially pointed out the fallacy or over-boldness of statements indulged in by enthusiastic supporters of wireless telegraphy. "The Electrician," therefore, in its issue of Feb. 28, makes an editorial reply, and after stating that it neither was nor is opposed to Mr. Marconi or partisan to cable-interests, it proceeds to discuss the remainder of Mr. Marconi's speech—

that referring to the working and possibilities of his system. The article is clear in language and sound in argument, and it should help to make clear in the minds of many the true status of wireless telegraphy; we therefore reprint it below, in slightly condensed form:

We have never failed to give due recognition to the actual accomplishments of the Marconi system, nor to tender to its able and ingenious inventor our sincere admiration for all that he has been able to perform. We have always fully and freely proclaimed that there is a wide field for wireless telegraphy, and have endeavored impartially to point out the directions in which it might expect to meet with success. It has never occurred to us to look upon wireless telegraphy as a probable, nor even a practically possible, competitor with the long-distance submarine cable. On the contrary, we have always considered it a feeder of the cable, or as capable of serving in places where ordinary cable telegraphy is impracticable. And we maintain this attitude still. Nothing publicly known of what Mr. Marconi has done—not even the absurdly overrated three "S's"—and nothing that he has said, justifies the faintest expectation that his system can ever be a serious rival to the ocean cable.

Let us examine Mr. Marconi's speech (above referred to, before the meeting of the Marconi Wireless Telegraph Co. in February, 1902—Ed.) in detail. First, we will take the question which Mr. Marconi admits to be "the most serious objection brought against his system"—viz., the lack of secrecy. Mr. Marconi denies this defect, and, with a show of boldness that must not be allowed to mislead our readers, he challenges Dr. Lodge and Sir William Preece to intercept his wireless messages. But the terms of the challenge are scarcely conclusive. It is not to be expected that either of these experts would be satisfied to use a neighboring Marconi station, while it is unreasonable to expect them to build for themselves a somewhat costly station, and with only a week for the task, when it is upon Mr. Marconi that the onus probandi should lie. Supposing that, for reasons of commercial rivalry or for any other hostile purpose, an attempt were to be made to tap Marconi messages; it might probably pay to spend a considerable sum of money, and to take much longer than a week to effect the purpose. Mr. Marconi makes great boast of being able to preserve secrecy, but he gives not the faintest hint of how this can be done—unless, indeed, he puts his trust in syntony. But syntony would be powerless to prevent any determined attempt to tap the signals which his sending stations scatter broadcast in all directions. It is true it might take some time to make the necessary adjustment of the tapping receiver; but, once this were to be done, every signal would be read as easily as at its appointed destination. In effect, Mr. Marconi claims to be able to disturb systematically the ether for hundreds of miles around his sending stations, while denying the physical possibility of any scientist erecting apparatus capable of detecting the disturbances. The contention is absurd on the face of it! If Mr. Marconi has nothing better than syntony to protect the messages entrusted to him, he must abandon his claim to secrecy.

Allied to the question of secrecy is the other matter of interference between stations. We do not deny that by means of syntony Mr. Marconi is able to prevent such interference between his own stations, when the number of those stations is kept within a certain limit; and perhaps two syntonic methods might be combined to get a greater number of selective systems. But we do deny that syntony or any other known process is capable of preventing his receiving stations from being interfered with, wilfully or otherwise, by signals emanating from wireless telegraph stations over which Mr. Marconi and his companies can exert no control whatever. He cannot imagine that he has a monopoly of all the ether in and around this planet, or even of the ether in the vicinity of the Atlantic. We assure him that neither his patents nor any other rights in which he trusts give him such a monopoly; but that, on the contrary, were he to succeed in establishing wireless communication between England and America, others, with at least equal right, would take their share in disturbing the ether also, with the result that Mr. Marconi's signals might find themselves in unwelcome company on their voyage across the Atlantic.

We will not push our criticisms further; all that can be said against Mr. Marconi's pretensions to rival ocean submarine telegraphy has been said already, and many times repeated, in our columns. It remains now for him and his advisers to discourage the flooding of the pages of the daily newspapers on both sides of the Atlantic with sensational statements, and to devote themselves entirely to the task of demonstrating practically, by actual trial on a sufficiently convincing scale, the possibility of sending a readable message across the Atlantic. When they have done that it will be quite time enough to discuss the questions of speed of signalling and to speculate as to the probable revenue.

Finally, we offer one point, which can be appreciated by all, to the advocates of wireless versus cable telegraphy to ponder over. Assume a commercial installation of the former between this country (England) and America. To say nothing of "interference," even an approaching electric storm, for example, makes a clean slate of Hertzian waves. It is certain that the loss of one message (or an important part of a message) a week—say 50 a year—would so utterly destroy public confidence in the reliability of the system that it would take years to regain it. Mr. Marconi, not very chivalrously, blames the operators for the utter failure of his system in the Hawaii Islands, where the distances are quite short. Bad signallers on cable lines make errors, but they do not lose whole telegrams.

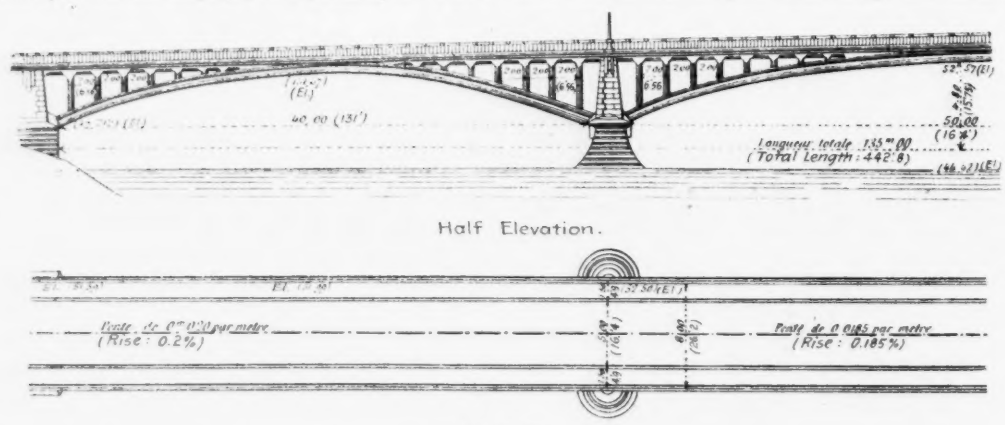


FIG. 1. ELEVATION AND PLAN OF CHATELLERAULT BRIDGE.

BRIDGE OF CONCRETE-STEEL, AT CHATELLERAULT, FRANCE.

In a lengthy article upon the application of combined concrete and metal work, published in the "Revue Generale des Chemins de Fer," for December, 1901, the following brief description is given of a concrete-steel bridge built over the river Vienne, at Chatellerault, France:

Except the iron parapet, all of the parts of this bridge, including the foundations, are built of concrete and steel rods. The total length of the bridge is 442.8 ft. between abutments; and it is made up of two side arches of 131.2 ft. span and 1-10-in. rise, and a central arch of 164 ft. with 15.75 ft. rise. The piers and abutments rest upon a grillage of concrete-steel, imbedded in the rock. Each pier is formed by four vertical metal supports, joined to the grillage; the exterior form is given by fine concrete face-work 5 ins. thick; and the interior, between the face and the four supports, is filled with ordinary concrete.

The arches are formed of four separate arch beams 1.64 ft. wide, and of variable heights, made of concrete and rods. The total width of the bridge over these arches is 19.68 ft. The side arches are 2.62 ft. deep at the springing line and 1.44 ft. at the crown; for the center arch these dimensions are 2.98 ft. and 1.77 ft., respectively. The round-iron rods used in the arches are continued through the piers.

The width of the bridge floor is 26.24 ft., and the two sidewalks are carried on brackets. This roadway is made up of concrete and interlaced round rods, 6 ins. in total thickness, and on this is laid the stone pavement. This concrete-steel floor is reinforced by four lines of beams, corresponding with the arch-beams of the bridge; and iron posts, spaced 6.56 ft. apart each way, transfer the load of the roadway to the arch-beams.

This bridge was built in less than three months, in August-November, 1899. It was tested with dead and rolling loads in 1900. Under the test by dead load, the roadway carried 163.8 lbs. to the sq. ft., instead of the 82 lbs. called for in the contract; the sidewalks carried 122.8 lbs. per sq. ft. Under conditions of the least favorable loading, the maximum depression of the arches was as follows: For the left-side arch, 6 mm.; for the right-side arch, 5 mm.; and for the middle arch, 10 mm. When the bridge was unloaded the arches returned to their initial height. This test gave a depression under load equivalent to 1-7,300th of the span, for the side arches; and 1-5,000th of the span for the center arch. The test by rolling load was equally satisfactory; the depression never exceeded 1-9,000th of the span, and the deformation in the arches was less than in the case of unequal loading with dead weight.

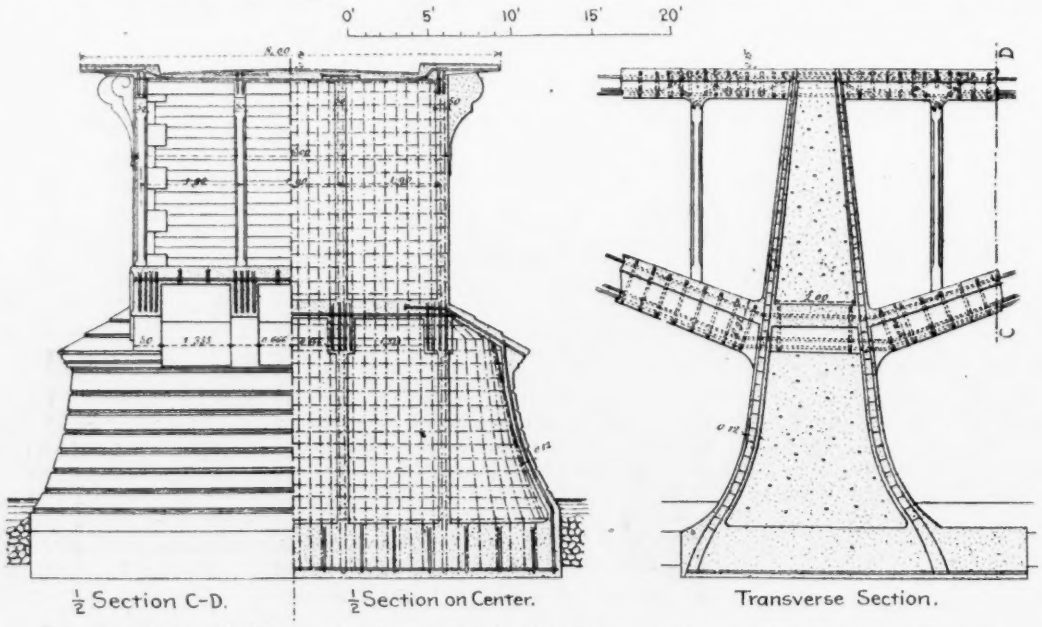


FIG. 2. CROSS-SECTION AND SIDE ELEVATION OF PIER OF CHATELLERAULT BRIDGE.

The total cost of this bridge—built under a forfeit, was $35,000; or about one-third the estimated cost of a bridge built in metal and masonry. This cost amounts to about $3 per sq. ft. of road surface. The Chatellerault bridge was built according to the Hennebique patents for armored concrete construction. These patents are represented in the United States by Mr. R. Baffrey, 1123 Broadway, New York city.

A WIRELESS TELEGRAPH SYSTEM is being installed between Banana and Ambrizette, and the cable terminals, in the Congo Region, by Mr. Paul de Bremaecker, of Brussels. At present telegrams have to be transported by boat to and from Saint Thomas, or Saint Paul de Loanda—the cable terminals, and Banana and Ambrizette, on the coast some distance north of these terminals.

THE 4, 5 AND 6-MASTED SCHOONERS are profitable, says the "Boston Journal." One schooner, with a gross tonnage of 1,904 and carrying capacity of 3,000 tons, has made 12 voyages in 312 days and has paid dividends amounting to nearly 39% on her cost of $72,960. Three other vessels paid an annual profit of 27.5% on the investment. Their net earnings were 42.9% of their gross receipts. There are now afloat about eighteen 5 and 6-masted schooners of 2,000 tons, while 377 schooners of over 500 tons gross register are owned on the Atlantic Coast. The largest schooner afloat is the 6-masted "Eleanor A. Percy," of Bath, Me., 3,410 tons gross, and the only other 6-master yet built is the "George W. Wells," 2,970 tons. A 7-masted steel schooner is being built by the Fore River Ship & Engine Building Co. for Capt. John C. Crowley. She will carry a cargo of 7,500 tons, spread 43,000 sq. ft. of sail and will be handled by a crew of 16 men.

DEDICATION OF THE GAYLEY LABORATORY, LAFAYETTE COLLEGE, EASTON, PA.

On April 5 the new laboratory of chemistry and metallurgy presented by Mr. James Gayley to Lafayette College was formally presented and dedicated in the presence of a large company, including many distinguished chemists, metallurgists and engineers. The exercises included an introductory address by Dr. Edward Hart, professor of chemistry in Lafayette College, who designed the arrangement of the interior of the new building and supervised its construction, and addresses on "The Significance of Chemical Laboratories" by Dr. Ira Remsen, president of Johns Hopkins University; on "The Contributions of Chemistry to Sanitary Science," by Dr. Thos. M. Drown, president of Lehigh University, and formerly professor of chemistry in Lafayette College; and on "Metallurgical Laboratories," by Dr. Henry M. Howe, professor of metallurgy in Columbia University. After these addresses had been delivered in Pardee Hall, the large audience, which included the whole body of students and professors, as well as many alumni and invited guests, marched in procession to the Gayley laboratory, where a brief address of presentation was made by Mr. James Gayley, the donor, followed by an address of acceptance by Dr. Warfield, president of the College, and a dedicatory prayer by Rev. Samuel A. Gayley, D. D., father of the donor, and an alumnus of the class of 1847. The invited guests were then escorted through the laboratory, and afterwards were entertained at luncheon in Pardee Hall.

The external appearance of the laboratory is seen in the half-tone cut herewith. It is a three-story fireproof building, 88 ft. long by 73 ft. deep, constructed of mottled brick faced with Indiana limestone. The floors and partitions are made of steel beams, expanded metal and concrete, all the metal work being covered with asphalt varnish to protect it from corrosion by acid fumes. The basement, 11 ft. high, contains the coal cellars, steam-heating apparatus, lavatory, lockers, storeroom, assay room, metallurgical laboratory, crystallizing room, and room for water and gas analyses, also a beginners' laboratory for 116 men. On the first floor, 14 ft. high, there is a wide hallway, with mosaic floor; the library room, containing a chemical library costing $5,000, the gift of Mr. Henry W. Oliver, of Pittsburg; a large lecture room for 125 men, the professors' offices and preparation room, stock room, and a laboratory for 44 advanced workers. The second story, 15 ft. high, contains the qualitative and quantitative laboratories, each for 44 men, a stock room, a quiz room, and a photographic room and dark room. Ventilation of the laboratories and hoods is provided by three 18-in. flues on each side of the building, each hood having three 6-in. openings into the flues.

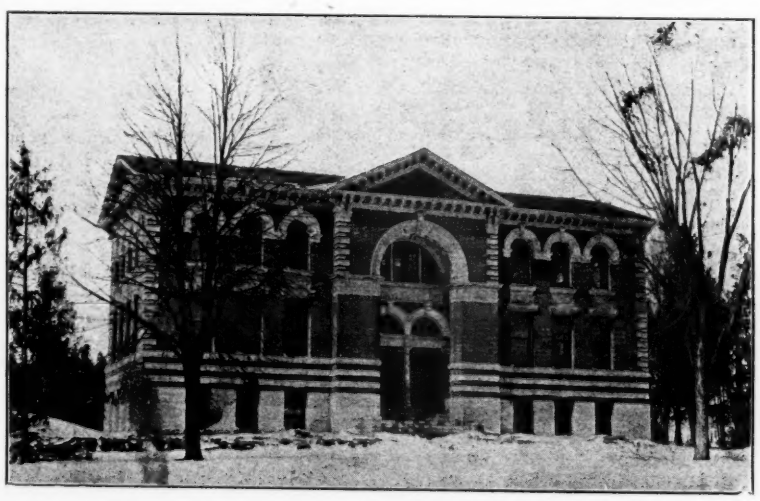
Mr. James Gayley, the donor of the laboratory, is a graduate of the class of 1876. He studied chemistry under Dr. Thomas M. Drown. After graduating he became the chemist of the Crane Iron Works, at Catasauqua, Pa., on a salary of $500 per year. After three years in this position he became manager of the blast furnaces of the Missouri Furnace Co., at Carondelet, Mo., and later held a similar position with the E. & G. Brooke Co., at Birdsboro, Pa. In 1885 he was appointed superintendent of the blast furnaces of

James Gayley.

the Carnegie Steel Co., at the Edgar Thomson steel works, under the late Capt. Wm. R. Jones, and he remained in the employ of the Carnegie Co. until its absorption by the U. S. Steel Corporation, in which he holds the position of first vice-president. His successful career is a direct development of his studies in chemistry at Lafayette College, and his gift of the laboratory is a most fitting acknowledgement of the benefits he there received.

In making the formal presentation of the building, Mr. Gayley said:

> As this is the age of industry, it is my great desire that the instruction given in this building shall so instill the spirit of industrialism, that it may cause men with the strongest brains and ambitions to direct their energies toward industrial advancement. And I rest content in the belief that there shall come from this institution, some men, who have profited by the instruction they have received in this building, and who shall mark progress in some of our nation's great industries.



The Gayley Laboratory, Lafayette College, Easton, Pa.

GERMAN EXPERIMENTS WITH SEWAGE TREATMENT BY SEPTIC TANKS AND CONTACT FILTER BEDS.*

An interesting pamphlet on the sewage disposal question has been prepared by Professor Dunbar and Dr. Thumm, and published by R. Oldenbourg, of Munich. In this publication are given the results of experiments extending over 3½ years with what in England is known as the bacterial treatment of sewage. The authors, however, prefer to distinguish the system of contact beds without previous septic action as the "oxidizing method," and septic tank followed by contact beds as the "putrefying method," and justify the term "oxidizing" by the statement that the function of the micro organisms and other higher life in the beds is to break up the organic matter deposited on the material, and thus prepare it for the oxidization which takes place through the absorption of oxygen from the atmosphere while the bed is empty. Special attention was directed to a comparison of these two methods, with the result that there was practically no difference in the amount of purification, and, contrary to the experience of many in this country, the reduction in the liquid capacity in the bed fed with the effluent from the septic tank was not less than that in the bed fed with fresh sewage without previous sedimentation. Mainly in consequence of this the authors decided in favor of the latter, but they appear to have overlooked the fact that in filling the bed from the septic tank the whole volume required, some 7,000 gallons—representing one-third of the total contents of the tank—was drawn off in bulk in a few minutes, whereas in actual practice this volume (one-third of a tank holding one day's flow) would pass through at a rate not exceeding 1,200 gallons per hour. This comparatively high rate of discharge from the tank, involving also the lowering of the scum through one-third of the depth of the tank, may quite possibly have caused a larger amount of suspended matter to be carried through to the bed than would be the case in actual practice, and this renders the comparison of the two methods of less value.

The most important experiments were made by the "oxidizing" method, and in beds with a liquid capacity of 7,000 to 8,000 gallons. The sewage treated was taken from the new General Hospital at Hamburg-Eppendorf, and from numerous comparative analyses it appears to have been equal in strength to that of the average town. The experiments may thus be taken as practical, something more than mere laboratory tests. The authors discuss at length the various means for judging the results, and give their reasons for adopting as the most suitable and certain the reduction of oxidizable matter as shown by the amount of oxygen absorbed from permanganate by Kubel's method. They also fix as a standard a percentage of purification of 65% as indicating a non-putrescible effluent. The method of working the beds, periods of contact, etc., and the material and its size, is varied frequently, and in all cases a satisfactory effluent is shown to be attainable with either single or double contact, and clinker is found to be the best material. Reference is made to the practice, approved by some English authors, of allowing for three fillings per day, and it is remarked that as far as single contact is concerned this is undoubtedly a considerable overworking of the beds and cannot be recommended. Here, again, the authors do not appear to be aware that in such schemes, and particularly in those sanctioned by our Local Government Board, provision is made for treating three times the dry weather flow, so that the beds receive three fillings per day only during excessive rainfall, the average number of fillings working out at probably one and a half per day.

Very elaborate data are given with reference to the reduction of the liquid capacity of the beds through sludging up and the means for overcoming this difficulty. This information is particularly interesting and valuable for comparison with the experience gained in this country. It should be borne in mind that these data refer to single contact without previous sedimentation. They find that with one filling per day, after 700 fillings, the original capacity of 33% is reduced to 19.9%, and with two fillings per day from 40% to 14%. To allow the beds periods of complete rest even four weeks at a time was found to be useless, as, although the volume taken by the bed immediately after the period of rest was considerably greater than before, this increase was completely lost again after two to three weeks of work. Forking over the surface and flushing or drenching out the material in situ made no perceptible improvement. Changing the method of filling at times to "upward" instead of "downward" had the effect of making the reduction in capacity less rapid but gave no permanent result, the sludging-up taking place eventually all the same. The only satisfactory method was found to be the removal of the material and carefully washing it with clean water against screens. By this method the original capacity was not only regained, but in some cases even increased. It was ascertained that about 10% of the bulk of the material was lost by washing, and the cost of this cleansing worked out at about 28 cts. per cu. yd. (labor costing 9 cts. per hour). Other smaller experiments were made with trade liquors, and it was proved that with double contact after sedimentation, but without previous septic treatment, the wastes from a beet-sugar factory, a brewery, a yeast factory and a tannery, could all be satisfactorily dealt with and a non-putrescible colorless effluent produced. The whole of the experiments appear to have been conducted with that careful attention to detail and accuracy which we usually expect from German scientific investigators, and the results now published form a valuable addition to our present knowledge of the subject.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

It is not always safe to judge the future by the past, and those who conclude from the published statistics of sail and steam tonnage that the sailing vessel is doomed to an early disappearance from the high seas, may find that the entrance of new elements into the problem will upset all their calculations.

We quote on our news page an item from a Boston paper showing that some of the large schooners which have been built in recent years on the Atlantic coast have earned profits of 27% to 39% per annum for their owners. One would have to travel a long way to find steam vessels earning any such profits. It is no wonder, under such circumstances, that more of these large schooners are being built.

The advantage of these vessels over the old-time square-rigged ship is only beginning to be appreciated. It lies largely in the fact that the schooner-rigged vessel can be handled by a very small crew. The newest and largest vessel of this type, with a cargo capacity of 7,500 tons, will carry a crew of only 16 men. The sails are handled from the deck, and steam power is available for the work. Thus, the arduous and dangerous work aloft which was necessary on the old-time square-rigged vessel is largely done away with. The reduction in the size of the crew is, of course, much more important on a sailing vessel than on a steam vessel, since the longer time taken on the voyage makes the cost of seamen's wages and board a much larger item in the running expenses than on a steam vessel.

Besides this, there are other advantages of the schooner rig. It is safer than the square rig, for the sails can be handled much more quickly in case of a sudden squall. It appears also probable that the expense through loss of sails and spars in storms will be much less. There is good reason to suppose that such vessels will compare well in safety with the average freight steamer, where the casualties from breakage of screw shafts have reached very serious proportions in recent years. The fact that steam power is available for pumping and for fog signaling is also a factor of importance in the matter of safety.

It is not at all unlikely that eventually auxiliary steam power may be adopted for vessels of this class, for use in calms, in entering harbors, or as an aid in keeping the vessel under way in case of storms. A steam plant of sufficient size for this would add little to the cost of the vessel or to its operating expenses, and would be worth all it cost in the added safety and in the reduction in time of the average voyage. The use of such auxiliary power plants on sailing vessels has in fact already attained large proportions, and seems certain to increase.

An excellent form of co-operation has been inaugurated by the engineering employees of the Westinghouse Electric Co., and might well be copied by engineers in the employ of other large concerns. A social club was recently organized, under the title of "The Electric Club," with 150 charter members, while as many more have since joined. Any of those connected with the apprenticeship courses or the engineering work of the Westinghouse Electric & Mfg. Co. is eligible for membership. The dues are set at $6 per year, and this amount is reduced 50% for engineering apprentices and to $1.50 per year in the case of three or four-year apprentices. The Westinghouse Co. also contributes to the expenses of the organization, paying the rental of the club rooms. The objects of the club are chiefly for social recreation, but co-operation in electrical and engineering studies is also planned. Reading rooms, classes, lectures, discussions on technical topics and excursions are among the departments of work outlined.

The advantages of such an organization are particularly great in the case of works located in an outlying suburb or isolated country town, where the population is often composed almost wholly of operatives. The young engineer, fresh from the pleasant social atmosphere of a college town, who is set down in the dull and barren atmosphere of a factory village, is often consumed with homesickness. In his leisure hours he has nothing to do, no place to go, and nowhere to meet other young men similarly situated, save confined quarters in a boarding-house. Under such circumstances such a social club as that organized by the Westinghouse engineers is calculated to do a great deal of good.

It was in Philadelphia, a few years ago, that water was discovered to have an injurious effect upon asphalt. It is Philadelphia investors, chiefly, who are now in mourning over the injurious effect of water in asphalt securities. The investigation of the Asphalt Trust's books, made by the Audit Co. of America, shows that the net earnings of the Trust were $326,748 in 1900 and $371,427 in 1901. It has issued $30,000,000 of 5% bonds and nearly an equal amount of other securities. Such financiering as this is nothing short of criminal. The man who sells a worthless thing to another, representing it to be of value, can be held responsible if his representations prove untrue, and a criminal charge can be maintained against him for fraud or for obtaining money under false pretences. This old-fashioned rule does not hold good, however, when it comes to buying and selling, not the actual physical things, but evidences of their ownership, viz.: stocks and bonds. Here the man who sells to innocent investors securities at prices several times their real value is termed an able financier, and those who are thus defrauded have no means of recovering their losses.

The tangle of overhead electric service wires which results from aerial construction has forced most of the larger cities of the country to insist upon having the wires, at least in the most crowded business sections, placed underground. A few of the smaller cities have recognized the gain in appearance and public safety resulting from such a course, and have secured the same improvement. Telephone companies, actuated chiefly from the desire to improve their service and reduce operating expenses, have done more towards burying their wires than all other classes of service combined. The last annual report of the American (Bell) Telephone & Telegraph Co. states that more than half the mileage of exchange wires throughout the country is underground. Information collected for "The Municipal Year Book," although probably quite incomplete in this particular, shows that of the 1,524 places of 3,000 and upwards by the last U. S. Census, 232 have some wires underground. In many instances this length placed in conduits is very small, but even a beginning is significant. Of the 232 cities, 197 reported telephone, 43 electric light, 27 fire or police alarm telegraph, and 14 street railway wires (trolley feeders) underground. While in many cities two or more classes of wires were underground, altogether only some 65 cities reported that other than telephone wires had been buried. All but 7 of the 78 cities having 50,000 population and over reported some wires underground. The two largest of these seven were Jersey City, N. J., 206,433, and Nashville, Tenn., 80,865. The other five places, in order of population, were Reading, Pa., Evansville, Ind., Charleston, S. C., Salt Lake City, Utah, and Elizabeth, N. J. Probably some of these places have wires underground, but failed to report the fact. The distribution, by size, of the 232 places which reported wires underground is as follows:

Populations of	Total places.	Places reporting wires underground.
50,000 and over	135	105
10,000 to 30,000	303	84
5,000 " 10,000	458	29
3,000 " 5,000	623	14

A complete list of cities with underground wires, together with particulars of kind, ownership and mileage of conduits, would be interesting. The telephone company named above doubtless has a large amount of information regarding its own wires. An officer of an allied telephone company stated, in a private letter to the editor, that in 1901 some wires were underground in 252 cities and towns of 3,000 population and upwards, but as the statement was not accompanied by the list of places, the information in "The Municipal Year Book" could not be revised and extended accordingly. It is certain, however, that the telephone companies are not only far in the lead in this branch of municipal betterment, but that they will continue so for many years to come. The progressive city of the future will insist that all wires be placed beneath the streets, always under municipal control, and often under municipal ownership. The ownership of most of the conduits thus far provided is vested in the companies that own the wires, but the reports include seven cities which own a part and seven others that own all the conduits in question.

Choosing a city engineer by popular vote is in many respects objectionable. When that course is the only one available, it is a pleasure to see a community take so sensible a course as was recently done at Burlington, Ia. In that city Mr. Emmett A. Steece, for some time City Engineer, was the only nominee for the office, and received 3,079 votes, with only three cast against him. This is certainly a compliment to Mr. Steece, as well as testimony to the good sense of the community.

The new 1902 catalogues of the American Society of Civil Engineers and the American Society of Mechanical Engineers have recently been issued, the former in a resplendent red paper cover, which will enable it to be easily distinguished from the other publications of the society in their regulation coat of sober gray, the latter in a new dress of type, evidently set on a linotype machine, which indicates that some of the economies in the running expenses of the society which were promised at the last annual meeting are being effected. It also appears that the "vest-pocket edition," or separate geographical catalogue of the members of the American Society of Me-

chanical Engineers, which has heretofore been issued twice a year, is hereafter to be issued once a year only, to take the place of the July edition of the alphabetical catalogue. Both these changes are likewise in the direction of wise economy.

Turning to the summary of membership, it appears that the two societies stand on a nearly equal footing. The detailed comparison is as follows:

	Am. Soc. C. E.	Am. Soc. M. E.
Hon. members	10	18
Members	1,512	1,607
Associate members	629	158
Associates	112	...
Juniors	255	542
Fellows and Cor. members	36	...
Total	2,554	2,325

It will be noticed that the Mechanical Engineers' Society has over twice as many juniors as the Civil Engineers. One reason for this is that in the latter society juniors must be promoted to a higher grade when they reach the age of 30 or else cease their connection with the society. No such rule exists in the Mechanical Engineers, and it is said that some men stay in the junior grade who are eligible for full membership because of the lower dues. A more important reason, probably, is the existence of the intermediate grade of Associate Membership in the Civil Engineers, to which juniors can be advanced when they reach the age of 26 if they are otherwise qualified.

AN EXHIBIT OF MUNICIPAL OWNERSHIP IN THE UNITED STATES.

Although there has of late been something of a lull in the stormy agitation for municipal ownership, the movement has nevertheless been steadily gaining in volume and strength. During such campaigns as that which closed at Chicago on April 1, with an overwhelming referendum vote for municipal street railways, gas and electric lighting plants, the subject attracts widespread popular attention. In the intervals between such seasons of active discussion, however, municipalities all over the country are quietly buying out private companies or building works on their own account.

Arguments for and against municipal ownership are frequently accompanied by more or less vague statements regarding the progress of the movement in some particular line of undertakings, but exact figures showing the relative extent of public and private ownership of any one industry have not heretofore been available.* It was partly with a view of supplying this deficiency that "The Municipal Year Book" was projected. The information there brought together makes possible for the first time an accurate statement of the extent to which cities of the United States own their "public utilities." In this work there is given for each city a list of all the chief public services owned by the city, and another list of those owned by private companies.

Taking first a general view of the whole country, it appears that (excluding cities which do not have the services named) nearly every municipality owns its sewerage system, over half own their public water supply, one-eighth or more own electric lighting plants.† Very few places own gas works, only one city owns and operates a street railway system, and not a single municipal telephone exchange is reported. There are, however, some municipal telephone fire-alarm, and possibly police, telegraph systems. Of the less common municipal services, a few cities own ferries, and a few others own conduits for underground wires, but none own commercial central heating stations.

If we omit sewerage systems (the private ownership of which is so rare as to be generally unknown, and which under public ownership rarely produce a revenue), water-works and electric lights are the only classes of service in which municipal ownership has been adopted to any considerable extent. The number and age of municipal gas plants, however, places municipal ownership in this field beyond the experimental stage. Municipal ferries, also, though few in number, have been in existence for a number of years.

Approaching municipal ownership from the size, rather than the number, of the cities served, it assumes, by the change, far greater prodominance over private ownership in the case of sewers and water-works. On the other hand, it becomes much less important than before in the case of electric lights and gas works. Municipal electric lighting plants, in particular, are few and far between in the larger cities of the country and increase rapidly in relation to private plants as the places diminish in size. The distribution of the municipal gas plants, among the various groups of population, is fairly uniform, although here, also, the majority of the works are in the smaller towns. It may be added that all the private sewerage companies are in places of less than 30,000 inhabitants, and all but two in places of less than 13,000, while for water-works it is notable that 8 of the 10, and 40 of the 50, largest cities of the country own their water-works plants.*

Thus far the attempt has been to give a bird's-

*An exception should be made to this statement with reference to systems of public water supply, where careful statistics of municipal and private ownership have been compiled in connection with "The Manual of American Water-Works."

†It should be understood that many of the municipal electric light plants have no commercial service, merely lighting the streets and public buildings.

*In a few of these cities relatively small parts of the population are supplied by private companies, but, on the other hand, New Orleans owns a large block of the stock of the local water company and has voted money for full municipal ownership.

TABLE I.—Municipal and Private Ownership in 1,524 Cities and Towns Having Populations of 3,000 or More by the U. S. Census of 1900.

	Water-works.	Sewers.*	Electric lights.	Gas works.	Street railways.	Telephones.
Places reporting systems	1,475	1,096	1,471	981	928	1,466
Public	766	1,045	193	20	1	0
Company	661	42	1,190	956	927	1,465
Both public and company	33	5	85	3	0	0
Joint	14	0	2	2	0	0
Ownership not given	1	4	1	0	0	1
None	46	411	51	533	589	43
No report	3	17	2	10	7	15

*Including those places, only, which have sewers for household wastes.

TABLE II.—Summary of Municipal and Private Ownership by Population Groups for Places of 3,000 Population and Over by the Census of 1900.

Population limits.	Places included.	Total reportg works.	Public.	Company.	Both.	Joint.	(?)*	None.	No report
Water-Works.									
30,000 and over	135	135	88	36	7	4	0	0	0
10,000 to 30,000	303	302	143	149	9	1	0	1	0
5,000 " 10,000	463	458	222	222	12	2	0	5	0
3,000 " 5,000	623	580	313	254	5	7	1	40	3
Total	1,524	1,475	766	661	33	14	1	46	3
Sewers.†									
30,000 and over	135	131	131	0	0	0	0	4	0
10,000 to 30,000	303	277	269	8	0	0	0	25	1
5,000 " 10,000	463	364	346	15	2	0	1	96	3
3,000 " 5,000	623	324	299	19	5	0	3	286	13
Total	1,524	1,096	1,045	42	5	0	4	411	17
Electric Lights.									
30,000 and over	135	135	4	121	10	0	0	0	0
10,000 to 30,000	303	302	22	249	31	0	0	1	0
5,000 " 10,000	463	455	56	371	26	1	1	7	1
3,000 " 5,000	623	579	111	449	18	1	0	43	1
Total	1,524	1,471	193	1,190	85	2	1	51	2
Gas.									
30,000 and over	135	133	3	128	1	1	0	2	0
10,000 to 30,000	303	285	5	279	1	0	0	18	0
5,000 " 10,000	463	342	5	336	1	0	0	119	2
3,000 " 5,000	623	221	7	213	0	1	0	394	8
Total	1,524	981	20	956	3	2	0	533	10
Street Railways.									
30,000 and over	135	135	0	135	0	0	0	0	0
10,000 to 30,000	303	285	0	285	0	0	0	18	0
5,000 " 10,000	463	293	0	293	0	0	0	170	0
3,000 " 5,000	623	215	1	214	0	0	0	401	7
Total	1,524	928	1	927	0	0	0	589	7
Telephones.									
30,000 and over	135	134	0	134	0	0	0	0	1
10,000 to 30,000	303	296	0	296	0	0	0	6	1
5,000 " 10,000	463	453	0	452	0	0	1	6	4
3,000 " 5,000	623	583	0	583	0	0	0	31	9
Total	1,524	1,466	0	1,465	0	0	1	43	15

*Ownership not given. †Including those places, only, which have sewers for household wastes.

TABLE V.—Gas Works under Municipal or Joint Ownership.

Philadelphia, Pa.	1,293,697[1]	Alexandria, Va.	14,528	Reading, Mass.	4,969
Louisville, Ky.	204,731[2]	Westfield, Mass.	12,310	Paris, Ky.	4,603
Richmond, Va.	85,050	Henderson, Ky.	10,272	Dalton, Ga.	4,315
Duluth, Minn.	52,969	Wakefield, Mass.	9,290	Danville, Ky.	4,285[6]
Wheeling, W. Va.	38,878	Middleboro, Mass.	6,885	Chanute, Kan.	4,208[4]
Hamilton, O.	23,914[3]	Bellefontaine, O.	6,649	Santa Clara, Cal.	3,650
Anderson, Ind.	20,178[4]	Charlottesville, Va	6,449	Dunkirk, Ind.	3,187
Danville, Va	16,520	Fredericksb'g, Va.	5,068		

[1]Both public and private works; the former are leased to the company. [2]Joint ownership; city owns $925,000 of company's stock. [3]Both public and private works. [4]Natural gas. [5]Supply from Wakefield municipal plant. [6]Joint ownership; city has one-fifth interest.

TABLE VI.—Places Having Sewerage Systems Owned by Companies or Individuals.

Place.	Population, 1900.	Owner.
Houlton, Me.	4,686	Houlton Sewer Co.
Derry, N. H.	3,583	Derry Sewerage Association.
Dudley, Mass.	3,553	Stevens Linen Works.
Manchester, Conn.	10,601	Cheney Brothers.
Asbury Park, N. J.	4,148	James A. Bradley.
Atlantic City, N. J.	27,838	Atlantic City Sewerage Co.
Burlington, N. J.	7,392	Burlington Sewerage Co.
Englewood, N. J.	6,253	Englewood Sewerage Co.; Citizens Sewerage Co.
Long Branch, N. J.	8,872	Long Branch Sewer Co.
Berwick, Pa.	3,916	The American Car & Foundry Co.
Gettysburg, Pa.(?)	3,495	Gettysburg Drainage Co.(?)
Lock Haven, Pa.	7,210	Not given.
Middletown, Pa.	5,608	Not given.
Olyphant,* Pa.	6,180	Olyphant Sewerage & Drainage Co.
Sayre, Pa.	5,243	Sayre Water Co.
Tyrone, Pa.	5,847	Not given.
Salisbury, Md.	4,277	Superintendent, J. E. Ellegood.
Wilmington, N. C.	20,976	Wilmington Sewer Co.(under construction)
Opelika, Ala.	4,245	Sanitary Sewerage Co., Philadelphia.
Natchez, Miss.	12,210	Natchez Water & Sewer Co.
Yazoo City, Mich.	4,944	Yazoo Improvement Co.
Shreveport, La.	16,013	Shreveport Water-Works Co.
Toronto, Ohio.	3,526	Toronto Sanitary Sewer Co.
Shelbyville, Ind.	7,169	Five companies.
Red Jacket, Mich.	4,668	Calumet & Hecla Co.†
Junction City, Kan.	4,695	J. K. Wright.
Newton, Kan.	6,208	Newton Sewer & Improvement Co.; South Side Sewer & Improvement Co.
Columbus, Neb.	3,522	Columbus Sewer Co.; East End Sewer Co.; West End Sewer Co.
Norfolk, Neb.	3,883	W. H. Rich.
Washington, Mo.	3,015	Various parties; city controls.
Austin, Tex.	22,258	Austin Sewerage Co.
Cleburne, Tex.	7,493	Mrs. E. J. Kelley.
Gainesville, Tex.	7,874	Gainesville Sewer Co.
Greenville, Tex.	6,860	Company.
McKinney,* Tex.	4,342	M. P. Kelley, Mgr.
Oak Cliff, Tex.	3,630	Oak Cliff Sewerage Co.
Palestine, Tex.(?)	8,297	Not given.
Temple, Tex.	7,065	Temple Sewer Co. (not in use).
Terrell, Tex.	6,330	New Odorless Sewerage Co.
Tyler,* Tex.	8,069	Tyler Sewerage Co.
Cripple Creek, Colo.	10,147	Cripple Creek Sewerage Co.
Leadville, Colo.	12,455	Leadville Sewerage Co.
Victor, Colo.	4,986	Victor Sewer Co.
Las Vegas, N. Mex.	3,552	Las Vegas Sewer Co. (partial system).
Salem, Ore.(?)	4,258	Not given.
Phoenix, Ariz.	5,544	Arizona Water-Works & Sewerage Co.
Pocatello, Idaho.	4,046	Oregon Short Line R. R. Co.

*Has publicly owned sewers, also.
†Apparently for its property, only, but the city sewers discharge through the company's outlet sewer.

eye view of municipal ownership throughout the United States. The detailed figures for sewers, water-works, electric lights, gas works, street railways and telephones are summarized for the whole country in Table I., for four groups of population in Table II., and for eight geographical groups of States in Table III. Since this study is primarily to show the status of ownership by cities, instead of by numbers of works,* it seemed desirable to give the totals for out-and-out municipal and private ownership, respectively, and to supplement these by columns showing, successively, the number of places having both public and private plants, joint ownership, and for which the ownership was not given. Then to complete the summaries it became necessary to give the number of cities where the respective services were entirely lacking, and also the number from which no information on the particular service in hand was obtained. It is a pleasure to state that the combined number of cases of unknown ownership and of no report whatever did not exceed 21 in any of the six services given in Tables I. to III., and ranged from that figure down to 3.

The summaries by population, Table II., were limited to four groups for the sake of simplicity and ease of comparison. The first of these groups was made to include all places of 30,000 and upwards, because, for the study in hand, practically every place of such a size has all the services named, while by going thus far down the scale of population the number of places included would be fairly large. Another reason for making the third group cover every city down to 30,000 was that this is the limit, set by Congress, to the "Statistics of Cities," published annually for three years past by the U. S. Department of Labor. The other three divisions of Table II. were chosen both for convenience and fitness.

Those who wish to know the status of municipal ownership within any smaller population group will find in the Introduction to "The Municipal Year Book" a table giving for each of the 1,524 cities and towns of 3,000 population and upwards the ownership of the nine services already mentioned in this article. The cities are there arranged in order of population, from greatest to least, and the population of each city is given. It will be a simple matter for any one interested in municipalities of, say, 25,000 to 30,000 population to make up a summary for water-works, electric lights, or any other service for places within that range of size. It is hoped, also, that the mere list of cities by populations will prove convenient to many engineers and municipal officials. It is hardly necessary to add that the table could not be reproduced here, since it would fill several pages of Engineering News.

The general bearing of Table II. has already been indicated. A few of its most suggestive features may be noted more specifically before leaving its details to those interested.

For water-works in places of 30,000 and upwards 88 cities show public to 36 private ownership, or nearly 2½ to 1. In the next group the division is almost equal, but slightly in favor of private works, and in the third it happens to be exactly equal. In the fourth group municipal ownership again leads. Probably if the figures were available for the 2,000 or more small places not included in "The Municipal Year Book," public ownership would be still more marked than in the places of 3,000 to 5,000. This is indicated by the summaries in "The Manual of American Water-Works" for 1897, combined with the probability that a decided majority of the small works erected since then have been built by cities, and the well-known fact that many cities and towns have bought out private water companies since the beginning of 1897.

The percentage of cities having municipally-owned electric lighting plants rises steadily with the decrease in population, there being only 4 public to 121 private plants in places of 30,000 and over, and 111 public to 449 private plants in towns of 3,000 to 5,000.

Table III. shows the ownership of water-works, sewers, electric lights, gas works, street railways and telephones, each separately, by groups of States. In Table IV. a comparison by States is made, both by means of actual numbers and percentages, between the total number of cities having water-works and electric light plants, and the number of municipally-owned works of these two classes. In this table the cities which have both public and private plants are added to those which have public works, only, in order to show the full extent of municipal ownership, with or without competition from private companies. The North Central States lead with 65.3 per cent. of their cities and towns having municipal ownership of water-works, and 30.5 per cent. of the electric light plants in the same category. The South Central States make the smallest showing (39.5 per cent.) for public ownership of water-works,

*The latter has been the practice in the Introductions to "The Manual of American Water-Works."

TABLE III.—Municipal and Private Ownership by Groups of States.

Group of States.	Total above 3,000.	Places reporting works.	Public.	Company.	Both.	Joint.	(?)*	None.	No report
Water-Works.									
New England.	234	226	140	83	3	0	0	8	0
Middle	337	335	131	188	9	7	0	2	0
South Atlantic	116	107	62	43	2	0	0	9	0
South Central	97	91	35	54	1	1	0	4	2
North Central	382	372	236	123	7	5	1	10	0
Northwestern	155	150	84	65	2	1	0	5	0
Southwestern	132	124	51	69	4	0	0	7	1
Pacific	71	70	27	38	5	0	0	1	0
Total	1,524	1,475	766	661	33	14	1	46	3
Sewers.†									
New England.	234	159	155	3	1	0	0	74	1
Middle	337	242	227	12	1	0	2	92	3
South Atlantic	116	70	69	1	0	0	0	44	2
South Central	97	55	49	4	0	0	2	38	4
North Central	382	305	302	2	1	0	0	73	4
Northwestern	155	120	116	4	0	0	0	34	1
Southwestern	132	85	70	13	2	0	0	45	2
Pacific	71	60	57	3	0	0	0	11	0
Total	1,524	1,096	1,045	42	5	0	4	411	17
Electric Lights.									
New England.	234	217	14	193	7	2	1	17	0
Middle	337	330	26	295	9	0	0	7	0
South Atlantic	116	109	25	78	6	0	0	7	0
South Central	97	90	14	71	5	0	0	7	0
North Central	382	377	77	262	38	0	0	3	2
Northwestern	155	147	26	114	7	0	0	8	0
Southwestern	132	131	6	116	9	0	0	1	0
Pacific	71	70	5	61	4	0	0	1	0
Total	1,524	1,471	193	1,190	85	2	1	51	2
Gas Works.									
New England	234	151	4	147	0	0	0	82	1
Middle	337	281	0	280	1	0	0	55	1
South Atlantic	116	59	7	52	6	0	0	51	0
South Central	97	47	2	43	0	2	0	48	2
North Central	382	260	3	255	2	0	0	119	3
Northwestern	155	83	3	80	0	0	0	71	1
Southwestern	132	50	0	50	0	0	0	80	2
Pacific	71	50	1	49	0	0	0	21	0
Total	1,524	981	20	956	3	2	0	533	10
Street Railways.									
New England.	234	200	0	200	0	0	0	34	0
Middle	337	266	0	266	0	0	0	71	0
South Atlantic	116	50	0	50	0	0	0	66	0
South Central	97	46	0	46	0	0	0	49	2
North Central	382	224	0	224	0	0	0	155	3
Northwestern	155	51	0	51	0	0	0	103	1
Southwestern	132	48	1	47	0	0	0	83	1
Pacific	71	43	0	43	0	0	0	28	0
Total	1,524	928	1	927	0	0	0	589	7
Telephones.									
New England.	234	219	0	219	0	0	0	13	2
Middle	337	228	0	328	0	0	0	8	1
South Atlantic	116	112	0	112	0	0	0	4	0
South Central	97	91	0	91	0	0	0	5	1
North Central	382	370	0	369	0	0	1	5	7
Northwestern	155	149	0	149	0	0	0	3	3
Southwestern	132	128	0	128	0	0	0	3	1
Pacific	71	69	0	69	0	0	0	2	0
Total	1,524	1,466	0	1,465	0	0	1	43	15

*Ownership unknown. †Including those places, only, which have sewers for household wastes.

TABLE IV.—Total Number of Places Having Water-Works and Electric Lights and the Number and Percentage Under Public Ownership, Given by States and Groups of States.*

States.	Places above 3,000.	Water-works. Total.	Water-works. Public. No.	Water-works. Public. Pr cent	Electric lights. Total.	Electric lights. Public. No.	Electric lights. Public. Pr cent
Maine	24	24	3	12.5	24	2	8.3
New Hampshire	20	20	11	55.0	20	0	0.0
Vermont	10	10	12	83.3	10	0	0.0
Massachusetts	135	128	97	75.8	121	17	14.0
Rhode Island	14	13	7	53.8	12	0	0.0
Connecticut	31	31	13	45.4	30	2	6.6
Total	234	226	143	63.2	217	21	9.7
New York	102	102	66	64.7	102	10	9.8
New Jersey	58	57	23	40.3	57	2	3.5
Pennsylvania	100	159	43	27.0	155	19	12.2
Delaware	3	3	2	66.6	3	1	33.3
Maryland	13	13	5	38.4	12	3	25.0
District of Columbia	1	1	1	100.0	1	0	0.0
Total	337	335	140	41.7	330	35	10.6
Virginia	23	23	14	60.8	23	5	21.6
West Virginia	12	12	6	50.0	12	2	16.6
North Carolina	24	19	10	52.6	21	7	33.3
South Carolina	20	19	11	57.8	20	6	33.3
Georgia	26	25	19	76.0	23	7	30.4
Florida	11	9	4	44.4	10	4	40.0
Total	116	107	64	59.8	109	31	28.4
Alabama	22	20	7	35.0	20	2	10.0
Mississippi	18	15	8	53.3	16	3	18.7
Louisiana	13	12	7	58.3	12	6	50.0
Tennessee	14	14	5	35.7	14	4	28.5
Kentucky	30	30	9	30.0	28	4	14.2
Total	97	91	36	39.5	90	19	21.1
Ohio	108	105	73	69.5	107	30	28.0
Indiana	72	68	42	61.0	72	31	43.0
Michigan	67	66	54	81.8	66	26	39.3
Illinois	83	83	54	65.0	80	24	30.0
Wisconsin	52	50	20	40.0	52	4	7.6
Total	382	372	243	65.3	377	115	30.5
Iowa	53	50	34	68.0	53	13	24.5
Minnesota	29	28	19	67.8	29	11	37.9
Kansas	36	35	15	42.8	29	4	13.7
Nebraska	17	17	9	52.9	16	3	18.7
South Dakota	7	7	3	42.8	7	1	14.2
North Dakota	3	3	2	66.6	3	1	33.3
Wyoming	3	3	2	66.6	3	0	0.0
Montana	7	7	2	28.5	7	0	0.0
Total	155	150	86	57.3	147	33	22.5
Missouri	40	39	10	25.6	40	7	17.5
Arkansas	11	10	2	20.0	11	1	9.1
Texas	50	47	25	53.1	49	7	14.2
Indian Territory	4	1	0	0.0	4	0	0.0
Oklahoma	6	6	4	66.6	6	0	0.0
Colorado	17	17	13	76.4	17	0	0.0
New Mexico	4	4	0	0.0	4	0	0.0
Total	132	124	54	43.5	131	15	11.6
Washington	13	13	7	53.8	13	3	23.0
Oregon	9	9	6	66.6	9	0	0.0
California	34	34	13	38.2	34	5	14.7
Arizona	3	3	2	66.6	3	0	0.0
Nevada	1	1	0	0.0	1	0	0.0
Utah	7	6	3	50.0	6	0	0.0
Idaho	2	2	0	0.0	2	0	0.0
Alaska	2	2	1	50.0	2	1	50.0
Total	71	70	32	45.7	70	9	12.9
Total, U. S...	1,524	1 475	799	54.2	1,471	278	19.0

*The columns for public works differ from those in the other tables in that they include places having both public and private works, instead of those which have public works only.

and the New England States, the smallest (9.7 per cent.) for electric lights.

Indian Territory, New Mexico, Nevada and Idaho have no public water-works, and there are 15 states and territories with no public electric light plants. Over 75 per cent. of the places in Vermont, Massachusetts, Georgia, Michigan and Colorado own their water-works, but for electric lights, outside those states where the percentages are misleading because the cities are so few, Indiana, Michigan and Minnesota are the only states in which over 35 per cent. of the electric lighting plants reported are owned by the municipalities, and in none of these does the percentage exceed 43.

Before dismissing the subject of municipal and private ownership, a few more words may be said regarding those services where one or the other class of ownership is in a decided minority. The 23 municipal gas works and the two plants under joint ownership are shown by Table V. The gas plants under full municipal ownership and operation range in size from the one at Richmond, Va., where the population is 85,050, to the one at Dunkirk, Ind., which place has 3,187 inhabitants. Two of the cities, Anderson, Ind., and Chanute, Kan., report that natural gas is the commodity supplied, and probably the same is true of a few other places. Toledo, O., was for many years one of the cities notable for its natural gas supply, but no municipal gas works were reported from that city.

There has long been an occasional demand for a list of places having private sewerage systems. Such a list is here made public (Table VI.) for the first time. It includes 47 places, in 5 of which there are also publicly-owned sewers. Some at least and probably a considerable number of these sewer systems serve only small proportions of the population, but the same is also true of many of the sewerage systems classed as public. Just how many of the 47 cities and towns have granted sewerage franchises, or their equivalent, and how many have permitted individuals or so-called companies to lay a few short lines of sewers for private convenience or, as a matter of neighborly co-operation, cannot be stated here. Definite statements on the subject would be welcome. New Jersey, Texas, and Pennsylvania have 22 of the 47 private sewerage systems, and in these and a few other states it appears that formal franchises have been granted by the municipalities.

Central heating stations were discussed at length in our issue of March 20.* Of the 82 cities reported as having ferries, some 10 or 12 are said to be owned by the municipalities, including those at New York, which are leased to private companies, and those at Boston, where there are private ferries, also.

Of the 232 cities and towns which reported that some of their electric wires were underground, the ownership was divided as follows: Private, 228; some private and some public, 7; public alone, 7. Wakefield, Mass., New Britain, Conn, Geneva and Utica, N. Y., Baltimore, Md., Akron, O., and Niles, Mich., reported public ownership, while Chelsea, Mass., Philadelphia and Pittsburg, Pa., Waycross, Ga., Bay City and Detroit, Mich., and Evanston, Ill., reported both public and private ownership. The kind of wires placed underground is discussed elsewhere in this issue.

The foregoing review makes no attempt to cover a large number of services which are always, or nearly always, under municipal ownership, or which, under private ownership, do not involve franchise rights. The "Municipal Year Book," however, aims to cover all highway bridges owned by companies and all instances of municipal bathhouses (see Engineering News for April 3), markets, parks, playgrounds, gymnasiums, cemeteries, docks, and fire and police alarm telegraphs. Most of these have no direct bearing upon the struggle between municipal and private ownership, but indirectly their number and variety indicates that in the future, franchise companies will be more and more frequently confronted with proposals for municipal ownership.

*In response to our request for notifications of errors or omissions in the list then given, we have been advised of the existence of a number of additional plants. These will be noted in a later issue, and also in the Introduction to "The Municipal Year Book."

LETTERS TO THE EDITOR.

Correct and Approximate Stresses in Lattice Trusses.

Sir: The common practice in figuring lattice trusses and other statically indeterminate structures has been to divide these structures or frames into two or more statically determinate systems. How far this practice is justified has been and is a matter of individual judgment. In simple cases it is not difficult to test this assumption, and the writer had occasion recently to make such a test.

The case was an ordinary double-intersection lattice truss, designed in the ordinary way for two 154-ton engines. From the general theory of statically indeterminate structures we get the expression for the stress X in any member x of a two-system frame free to move at one end:

$$X = \pm \frac{\Sigma\, S_1 S_0 \frac{l}{A}}{\Sigma\, S_1^2 \frac{l}{A} + \frac{l_x}{A_x}}$$

where

S_1 = stress in any member of truss when X = 1;
S_0 = stress in member when X = 0;
l = length of member;
A = cross-section of member;
l_x = length of member x;
A_x = cross-section of member x;

and the summation is extended over all the members of the truss. Upon using this formula for the calculation of the double-intersection lattice truss in question it was found that the stresses in the chord members differed from the stresses obtained by the ordinary method by amounts entirely within the limits of error of the calculation. The same was true of the web members toward the ends of the truss; the only differences of any importance were in the web members at the center of the truss, but even here the differences were not enough to materially affect the sections. In fact, the result was the conclusion that for an ordinary two-system lattice truss the stress-calculation by the common method may be considered just as exact as for a Pratt truss.

This, of course, does not justify generalization. For a four-system lattice truss the result may be another one; however, a test even in this case is a mere matter of work, though of very much more work than in the case of a two-system truss. S.

Chicago, Ill., March 22, 1902.

Another Method of Work in Relining Railway Curves.

Sir: The method of relining railroad curves, as given in the article published on Feb. 27 in your journal, seems to be the prevailing one—as those in the preceding numbers were along the same line.

But I have had better success by guessing where the P. C. was; and as there are in most offices notes of the curves as originally staked, using the old degree of curve. Of course I run off the bank in about 500 ft. I then measure the distance to the center of the track, and divide by the sine of twice the deflected angle, and move my P. C. back or ahead according as my curve ran off the inside or outside of the track. From the second P. C. I will usually get around without trouble. At each turning point I set a tack, either ahead or back of the turning point, and on a line parallel to the tangent from which I started; so that by stretching a string from my turning point to the tack, I can set my new turning point (as explained below) without setting up my instrument.

When I have reached the end and turned off a tangent parallel to the proposed tangent for my total angle, and figured the amount to "pull" ahead or back to come into the tangent, I can move my turning point along the said line parallel to my original tangent the same distance I move my P. C., and I have the whole curve established. Or, if necessary to change the degree, I have a curve that shows me just what my throw will be at every point, so it is very easy to ascertain what change it would be necessary to make in the external to fit the track as closely as possible; then, by turning around the curve again and establishing my turning points as before I will, by moving my P.C. a little one way or the other and by adjusting my turning point as explained above, have a curve which gives the least amount of work; and will check for length and deflections.

My objections to Mr. Leffler's methods are that while the curve will fit the track at the quarter and middle points as nearly as possible, yet it may give more throw than necessary at every other point; or possibly throw nearly all the track in one direction, thereby necessitating the undesirable splicing or cutting of rails; and then too, in a long calculation in the field, there is certainly a great chance of error.

If the curve is over 2°, I run from an offset, which will allow of a transition.

The above method is not original with myself, but I give it thinking it may be of interest to some readers of the Engineering News. I have used it successfully in curves 5,000 ft. in length, and can generally stake and fit a curve 2,000 ft. long in a day.

R. W. Willis.

Engineer's Office, C., B. & Q. Ry., Galesburg, Ill., March 29, 1902.

Moving Load Shears in Trusses with Parallel Chords.

Sir: The following simple method of obtaining the maximum web-stresses in trusses with parallel chords may be of interest to some of your readers. It is believed to be novel, and, besides being of theoretical interest, to have direct practical value. It was arrived at by the writer in the course of an extended study of the relations of shears and bending moments in trusses under concentrated loading, and has been completely developed for all cases in

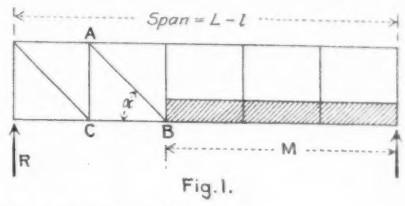


Fig. 1.

connection with the problem of equivalent loads. On the latter subject the writer hopes to present a paper to the profession, in the near future.

If we consider a span of length L − l loaded with a distributed load of p per unit of length and covering the length M (see Fig. 1) we have:

$$\text{Stress in A C} = \text{shear at B} = R = \frac{p\,M^2}{2\,(L-l)} \qquad (1)$$

$$\text{Stress in A B} = \frac{R}{\sin \alpha}.$$

If we now consider a span L with the same distributed load of p per unit of length and if we call r the reaction at C of the load p x in panel C B (other values as shown in Fig. 2), we have:

$$\text{Stress in A C} = R - r;$$

$$\text{Stress in A B} = \frac{R - r}{\sin \alpha};$$

$$R = \frac{p\,(M+x)^2}{2\,L} = \frac{p}{2\,L}(M^2 + 2\,Mx + x^2);$$

$$r = \frac{p\,x^2}{2\,l};$$

then

$$R - r = \frac{p}{2}\left\{\frac{x^2}{L} - \frac{x^2}{l} + \frac{2\,Mx}{L} + \frac{M^2}{L}\right\}.$$

Differentiating this expression with respect to x, we obtain

$$\frac{d\,(R-r)}{d\,x} = p\left\{\frac{x}{L} - \frac{x}{l} + \frac{M}{L}\right\}$$

$$= \frac{p}{L\,l}\,[M\,l - x\,(L-l)],$$

and equating this to zero, for a maximum value of (R − r), we find,

$$x = \frac{M\,l}{L-l}.$$

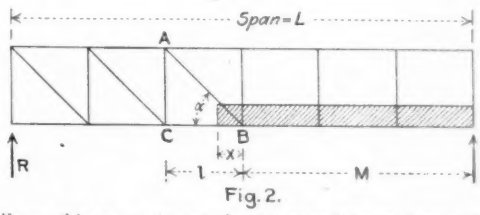


Fig. 2.

From this we may get, by transposition and substitution, the criterion for the position of maximum shear:

$$\frac{p\,x}{l} = \frac{p\,(M+x)}{L}.$$

Substituting the value of x in the expression for R − r, gives the maximum value of the shear:

$$(R-r)_{max} = \frac{p}{2}\left\{\frac{M^2 l^2}{(L-l)^2}\left\{\frac{1}{L} - \frac{1}{l}\right\} + \frac{2\,M^2\,l}{L\,(L-l)} + \frac{M^2}{L}\right\}$$

$$= \frac{p\,M^2}{2\,L}\left\{\frac{2\,l}{L-l} - \frac{l}{L-l} + 1\right\};$$

$$= \frac{p\,M^2}{2\,L}\left\{\frac{L}{L-l}\right\},$$

or, finally,

$$(R-r)_{max} = \frac{p\,M^2}{2\,(L-l)}. \qquad (2)$$

Comparing equations (2) and (1), we see that the maximum stress in a post A C in a span L is the same as the direct shear in a span L − l loaded from the end to the point at which the shear is to be found.

We can also write

$$(R-r)_{max} = \frac{p\,M^2}{2\,(L-l)} = \frac{p\,M}{2} \times \frac{M}{L-l}.$$

Since $\frac{p\,M}{2}$ is the maximum end shear in a span of length M, we see that the problem of finding maximum stresses in web members is directly related to the problem of maximum end shears, which latter is of very easy solution.

H. E. Vautelet,
Assistant Chief Engineer, Canadian Pacific Railway Co.

Montreal, P. Q., March 18, 1902.

Concerning Work Done Under the Corps of Engineers.

Sir: A number of letters have recently been printed in the correspondence columns of Engineering News with regard to the advisability of placing the construction of the Isthmian Canal in the hands of others than the members of the Corps of Engineers of the Army. It is not now intended to join in any discussion on the merits of this question nor express doubt for a moment of the motives of any of those engineers who advocate civil commissions for this purpose, nor even to refer to the probability of what course will be considered best for the interests of the work by Congress. It seems sufficient to say that no officer of the Corps of Engineers is ever given any extra compensation for the civil engineering work in connection with the improvement of the country's waterways, to convince any reasonable person that the interest and zeal shown by the members of the Corps in these improvements is prompted solely by their sense of duty and their professional pride in their Corps and its achievements.

What specially challenges comment is the apparently popular complaint that the supposed inflexibility of the regulations and of the red tape of the Engineer Department prevents economical performance of work, causes unnecessary expense and delay, and is incompatible with the efficiency procurable by other organizations.

It probably never occurs to those who offer such arguments that this red tape and these regulations are not distinctly army rules, but are requirements prescribed by the laws of Congress and interpreted by the Treasury Department and other officials, and apply to all similar government work by whomsoever conducted, and will undoubtedly apply to all work and expenditures on the Isthmian Canal, unless specially excepted by further act of Congress.

The legislation fixing eight hours as a day's work, that applying the civil service rules to government employees, the methods of making expenditures and rendering accounts, are all prescribed by law for the protection of the government and its people, and it is hard to see how the proposed civilian commissions will be able to avoid following these provisions or how they can have any more flexibility in such matters than is now enjoyed.

The delay in some of the government works under charge of officers of the Corps of Engineers is also frequently ascribed to the red tape entanglements of the War and Treasury departments. Did any of those who take such positions ever question the full accuracy of these statements or investigate the uneconomic method of making many of the appropriations for public work, the lack of harmony between the size of appropriations and the needs of the work and the frequently long periods between appropriations on what should be continuous work? I feel safe in saying that none regret these delays more than the officers themselves who are in charge.

There are but few who will not recognize that the eight-hour law, the civil service rules and the prescribed methods of keeping records and money accounts, cause expense; but the source of these requirements is the same as the appropriations themselves.

The orders governing the offices of the Corps of Engineers have for years shown that the aim of the Corps has uniformly been to keep the work in its charge on as near a good, efficient business basis as can be done.

Very respectfully,

Wm. M. Harts, Capt. Corps of Engineers.

Cuartel de Malate, Manila, P. I., March 8, 1902.

(We fully appreciate the good work, done often under great difficulties, by the officers of the Corps of Engineers and their assistants. It is certainly true that Congressional action—and inaction—is largely to blame for these difficulties and for increased expense in the conduct of government works. But it seems to us this is one of the strongest arguments for the creation of a commission to take charge of a work of such importance as the Isthmian Canal. It is known by experience that Congress too often turns a deaf ear to the recommendations and appeals of engineer officers. It can do this because such reports attract little public attention. But it could not lightly ignore the recommendations of a special commission made up of men of national reputation. For illustration, suppose the canal were under construction and some great contracting firm with strong political backing attempted to carry some scheme for its benefit through Congress and this scheme were opposed by those in charge of the work. Which would attract the most support in Congress—the appeal of an engineer officer, or the vigorous and authoritative presentment of a commission made up in such a manner as the present Isthmian Canal Commission, for example?

Captain Harts says truly that the members of his corps receive no additional compensation for their engineering work in connection with river and harbor improvements; and this is an excellent reason why a different organization ought to be put in charge of the canal enterprise. In an editorial discussion on "The Position of U. S. Assistant Engineers" in our issue of Aug. 4, 1898, we strongly urged that the officers of the Corps of Engineers and their civilian assistants should be given salaries commensurate with the responsibilities they have to carry. If this is true of work in the United States, it is far more true of work to be done in the tropical swamps of Central America. The country will be the loser in the long run if it attempts to build the largest engineering work that civilized man has ever undertaken with such engineers as can be hired to risk life and health in a tropical country for the salaries paid to U. S. assistant engineers.

Capt. Harts thinks that if a commission were to be put in charge of the canal work, it might be burdened with restrictions similar to those that hamper the work of engineer officers. At least, however, it would be able to pay salaries sufficient to secure a competent engineering staff; and if it found itself hampered by existing red tape it could appeal to Congress for the removal of the restrictions with much better chances of success than an engineer officer could.—Ed.)

Methods of Running Transit and Stadia Surveys.

Sir: The writer has no disposition to cavil at men or methods, but after reading the article on the planetable and stadia method of surveying in your issue of March 13 he feels like contributing something on the subject to benefit the men who are in private practice and to whom contour surveys come infrequently and are of limited extent.

The first thing which strikes the ordinary private practitioner upon reading articles on stadia and planetable surveying is the size of the party and the subdivision of the work.

Now, the writer has used the Johnson planetable and has worked with a planetable party, and he knows that the most extreme advocates of that method are not far wrong in all their claims. He knows, also, that the average engineer looks askance at the planetable because his instructions in its use has been limited, and at school, after has has mastered the principles, his instruction is considered complete. With the stadia and transit he does a little more work at school because there are a few mathematical principles to be understood first, and therefore it is a little harder to master and his memory retains it better.

Yet the writer has run across engineers who also look askance at the transit and stadia, and who contour large areas by laboriously subdividing them into parallelograms with a transit and then go over the work with a level, taking the elevations at each corner. The work is completed by pacing and sketching, the result being a contour map which may or may not be of value for the purpose contemplated. If the work is of very great extent, they will run transit lines, setting stakes 50 ft. to 100 ft. apart, as in a railroad survey, taking levels and topography precisely as in such surveys. Sometimes the side slopes are taken with hand level and rod, sometimes with a slope board and clinometer, and sometimes "by guess and by God," as one old man profanely put it. To talk to such men about the superiority of the transit and stadia is akin to preaching to the heathen, and to talk to them of planetable and stadia is a harder job. To them a contour map is simply a general guide to the country and not a thing to work closely on.

We are told that a planetable and stadia party should consist of seven men, as follows: Topographer, assistant, two rodmen, two axmen and one pacer. In figuring the cost, we are told the topographer gets $50 per month, the assistant $20, the rodmen each $20, the axmen each $15. That may be good pay in the southeastern corner of the United States, but in the West we have to pay about $75 to $90 for the topographer, from $45 to $60 for the assistant, not less than $30 for the rodmen and axmen, and for such a man as the pacer is indicated to be we would have to pay the same as for the topographer—that is, from $75 to $90. There might be such a thing as getting students on their summer vacation at less rates, but it is an uncertain kind of help to rely upon. The pay of the chief will be generally a trifle higher in the East than in the West, for there is a more general level of pay in the West, the mediocre men getting little less than the best. For a cook I do not know how much would be paid in the locality where the low-priced work is done, but in the West it is a poor cook who gets less than $50 per month, and to have things just as they should be he requires a flunky.

For the engineer in private practice, called upon suddenly to make a contour survey, the planetable and stadia method is not the best, for he has to do the work quickly and on short notice, and has no time to break in a party—remembering, of course, that the man referred to is one who does not make a specialty of that class of work, but does it in the ordinary course of an ordinary business.

The writer has used the transit and stadia a great deal. The party consists of himself, of two rodmen and as many axmen as circumstances demand. For a small survey he often uses only one rodman. For a survey 15 miles long of a crooked river with precipitous banks as a preliminary survey for the location of a logging road he had two rodmen, four axmen, two packers and one cook. The animal outfit consisted of six pack horses. Everything was comfortable.

For ordinary surveys of small extent, such as are incident to his work as a city engineer and preliminary examinations for small parks, road surveys, etc., he has two rods of a pattern devised by himself. These rods are 3 ins. wide and 8 ft. long. There are no figures on the rods, so they can be turned upside down if the rodman accidentally places them so and no harm will be done. To hold them as nearly as possible perpendicularly, a long metal arrow is hung on the back and on one edge, the point of suspension and the point of the arrow being on a scribed line. With these rods readings to the nearest foot can be taken. For more extended work a rod 16 ft. long is used. This is 3 ins. wide on the bottom and 1½ ins. wide at the top. Figures are painted on these rods and so placed that the observer can tell at a glance which figure to read when the rod is so far away that he has difficulty in deciphering the figure. With such rods the distance can be read to the nearest 5 ft. at a distance of more than a quarter of a mile, and if the light is right it can be estimated closer. To insure the verticality of these rods, a plummet is hung at the back, the string passing through a small plate screwed on the back and having a hole in it a little larger than the string out from the back of the rod a distance equal to that of the point of suspension.

The 15-mile survey mentioned above occupied 17 days, as the country was rather broken and in places wooded. The chief received $10 per day, the rodmen $1.75, the axmen $1, the cook $2, the packers $1.25, and for each pack horse 50 cts. per day; this, of course, in addition to rations, which averaged about 35 cts. per day for each. Incidental expenses were $42 on the job.

Owing to the light, field work closed early, and on going into camp the readings were reduced. It took five days to complete the map with 5-ft. and in some places 10-ft. contours. The writer had one man to help him for three days. Upon locating afterwards on this survey, the work was found to have been very satisfactory. The whole job was much cheaper than it would have been had regular railroad survey methods been used. If the survey had been for a regulation railroad instead of a logging road, on which less attention is paid to refinements in economies, the survey would have probably taken a little more time. A paper location was made on this map and the location run in and revised as the line was located. The graders commenced work after one mile had been located and pushed the cross-section party closely.

To make this survey, the writer had to hustle about as follows: At 5 o'clock in the evening he received a telephone call, which was responded to promptly by calling at the office of the company. He was asked if he could start the next noon for the woods and do some surveying the superintendent wanted done. He was told that all the men needed could be obtained on the ground, and the company did not care to pay traveling expenses for any men he would take with him. So he got away, simply taking the two shorter stadia rods as a precautionary measure, not knowing the kind of surveying wanted. A day and a half were consumed in traveling, and on getting to camp he was rushed out into the woods, instruments and all, to see the superintendent on the ground. Such experiences are common. To have talked of going back for the planetable and assistant, with his umbrella, and for two trained rodmen and a pacer would have resulted in the loss of a good job which brought others in the vicinity.

It was with relief the superintendent noted the smallness of the party. He had expected to assist himself by running the level and having the writer act as chief of party and transitman, employing two chainmen, a blackflag, a rodman, a slopeman and assistant and a "hull slough" of axmen and brushcutters. He expected such a party to be formed and have it work from 5 a. m. to 7 p. m., with a cold lunch at noon. Instead of that we went to work when it was light enough and quit when it commenced to get gloomy, and we had a hot lunch at noon, with a comfortable camp, plenty of tobacco and the latest magazines after the day's reduction of notes was completed. The superintendent noted with approval the progress of the party, and came on horseback to bring mail every other day. How many engineers have had similar experiences about starting off on work of which the head men in the city know little except that the superintendent wants a "surveyor at once."

For such a class of work the private practitioner should be well trained in transit and stadia surveying. A survey was lately made of a reservoir site, and to get all the information nearly a square mile of land was surveyed. Considerable detail work was done in order that a map on a scale of 400 ft., one on a scale of 100 ft., and

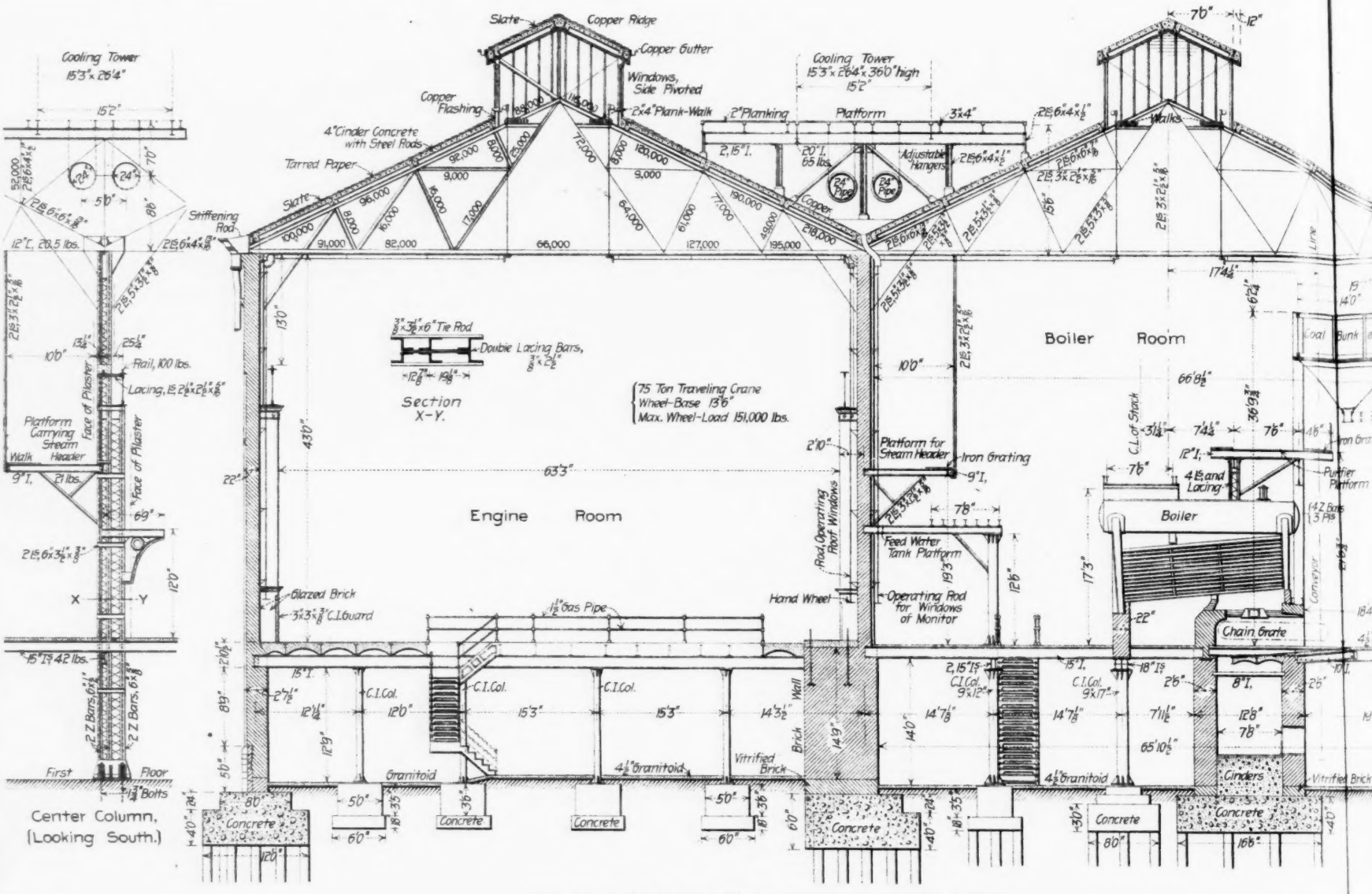
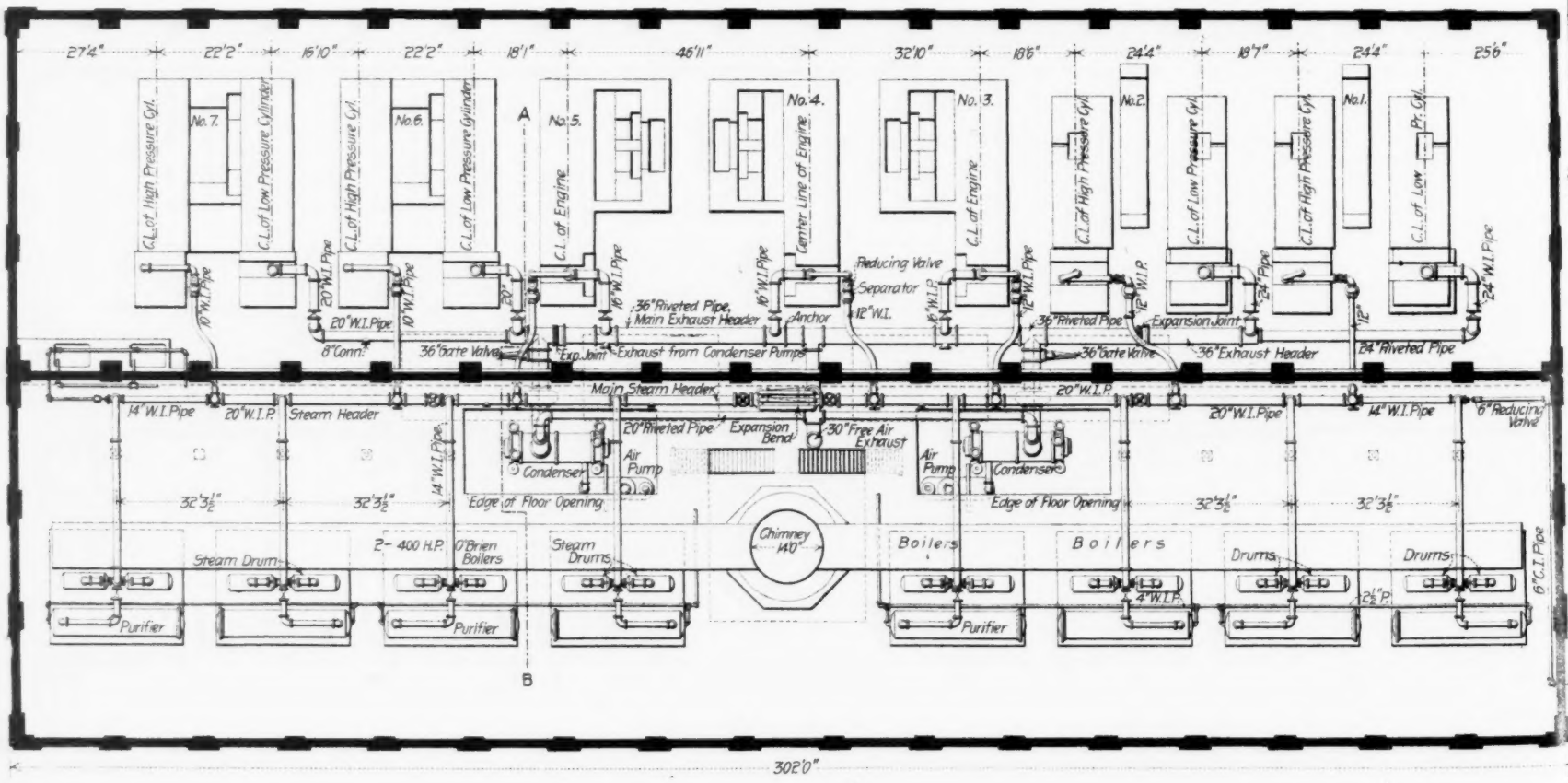
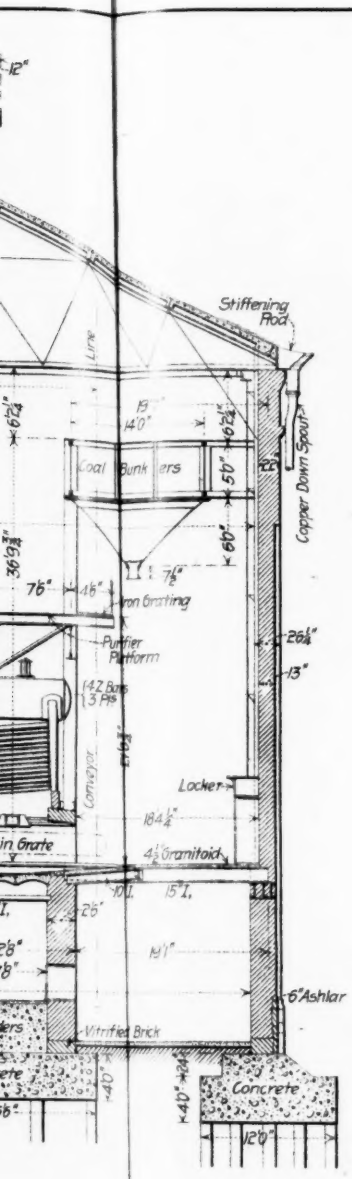


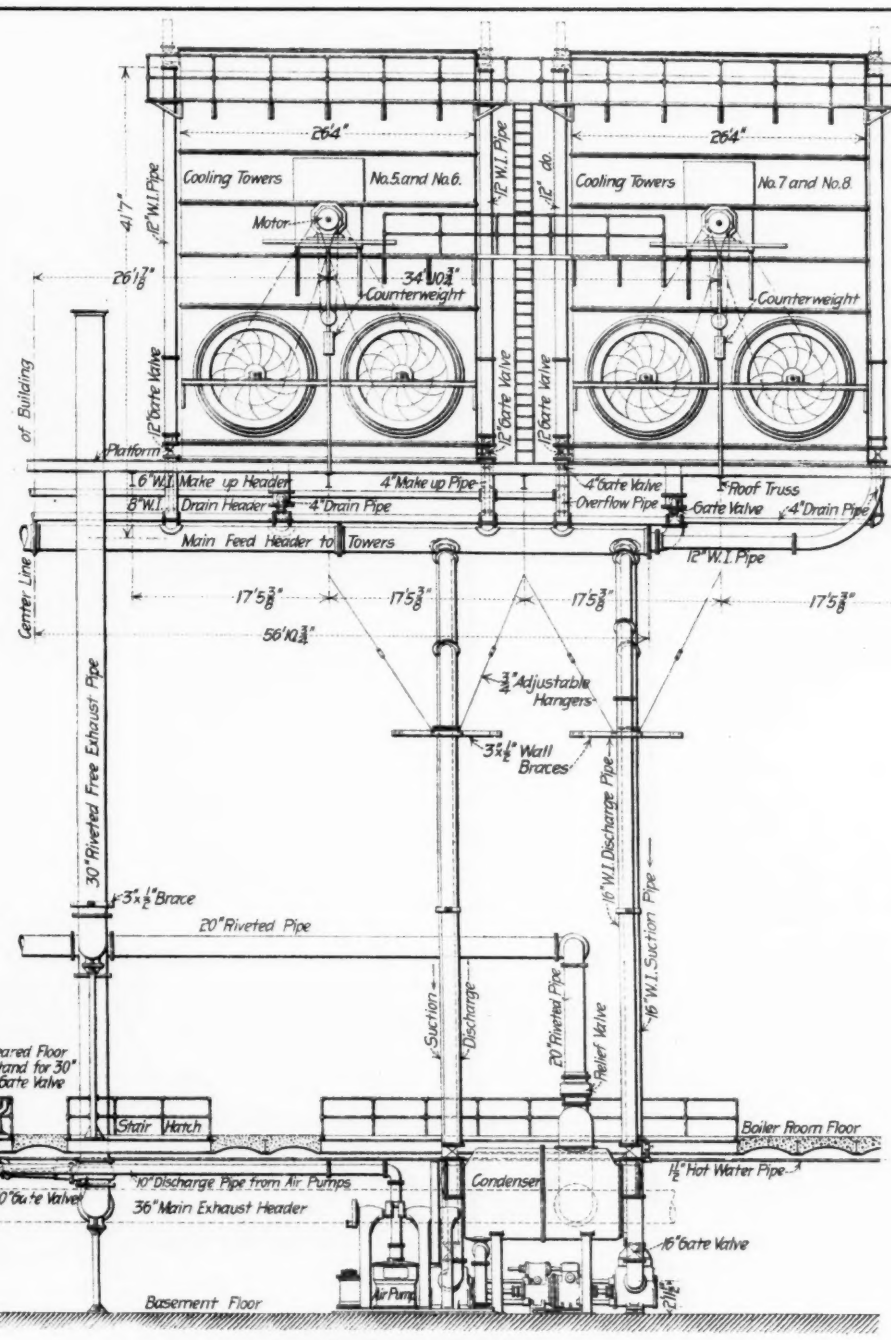
FIG. 11. CROSS SECTION OF STATION (LOOKING NORTH).



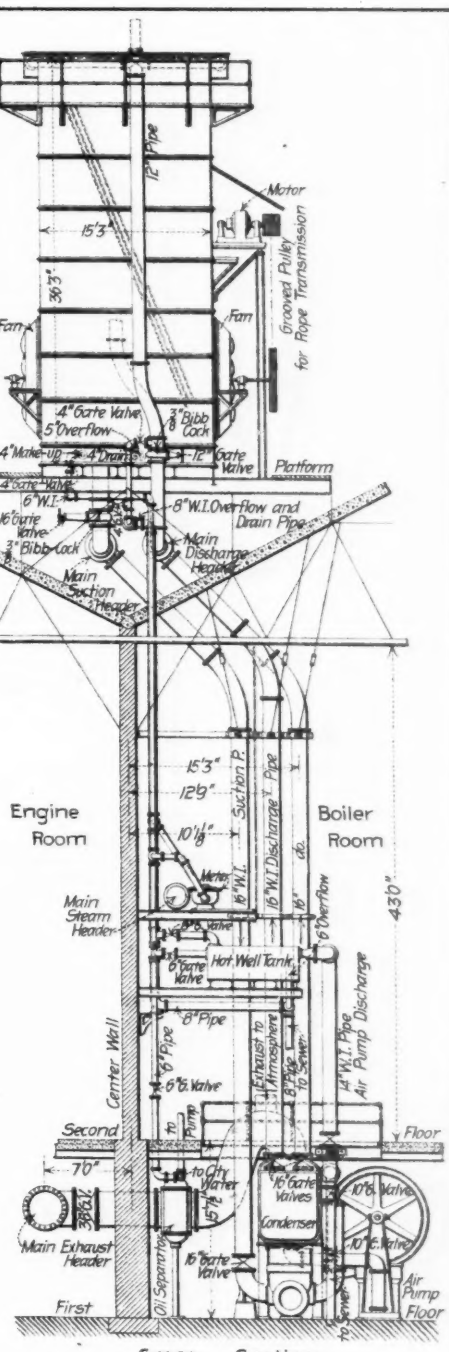
Sectional Plan.

FIG. 12. PLAN AND SECTION OF STATION, WITH STEAM AND EXHA



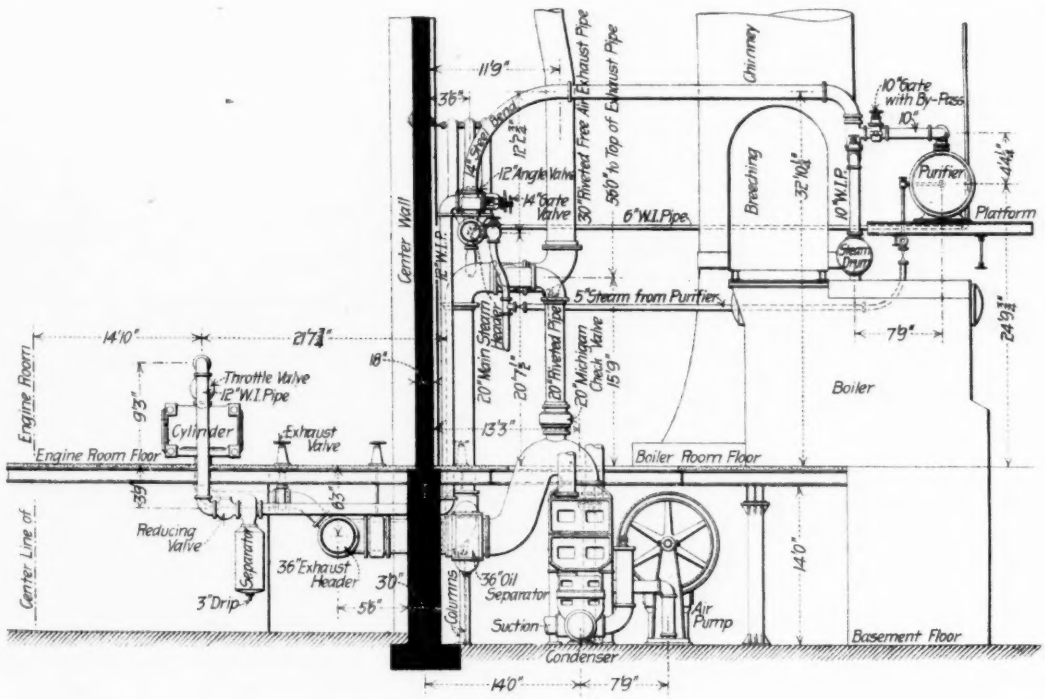


Longitudinal Section.



Cross Section.

FIG. 13. CONDENSING AND COOLING PLANT.



Section A-B.

THE
NORTHERN
POWER STATION
OF THE
ST. LOUIS TRANSIT CO.,
ST. LOUIS, MO.

W. D. Boyce & Co.,
St. Louis, Mo.,
Consulting and
Supervising Engineers.

TEAM AND EXHAUST PIPING.

CHAS. HART, LITH., 86 VESEY ST., N. Y.

of some portions one on a scale of 50 ft. might be made. The cost was $75.

The number of shots taken will run from 400 to 600 per day. On the reservoir site survey mentioned only one map was made, that on a scale of 400 ft. When required the others can be made. One rodman was used. Another survey has just been completed for a wire-rope tramway. The horizontal distance was 1¾ miles and the difference in elevation over 2,000 ft. Two rodmen were used and the topography taken in a strip 300 ft. wide. Time consumed, 7½ hours.

The writer has found the principal cause for dissatisfaction with stadia surveys to exist in the methods pursued by the novice, who will take an ordinary leveling rod and omit to take check readings. The only way to do the work right is to have two rods plainly graduated and use two rodmen, one to go before and the other to follow, the front rodman to take all sights on the right of the line as it proceeds and the rear rodman to take the sights on the left of the line as he follows. After setting an instrument point, the front rodman waits the coming of the instrument man to receive further instructions, and the rear rodman proceeds to occupy the station just left. A check reading is taken to him and the instrument oriented. If an error has been made in the rod reading or vertical angle, it is at once detected. If the survey is small and one rodman is used, he has to come back to the instrument point while the instrument man goes forward to the new one. By taking two readings thus over each line of sight between instrument stations, the liability to error is greatly lessened.

To compute line readings, it is necessary to use the proper formula and take a mean of readings where any difference occurs if the difference is slight. The side shots can be computed by means of a diagram or slide rule, several excellent ones being in the market.

Another source of error is an alteration in the wire interval. The writer suffered seriously several times from it. The vaunted excellence of fixed stadia hairs is a delusion and a snare when used in an ordinary transit. A very little change in the hairs makes a great difference in the work, and it is a cumulative error. He has had adjustable wires placed in his transit, and experiences more peace of mind than before. The interval must be tested before commencing a piece of work, and is best done by measuring off a line several hundred feet long, plus the constant, and then, with the rod held at one end and the instrument set at the other, adjust the wires to the distance read. It is a matter requiring only a few moments' time. Before quitting work for the night, the last distance read between instrument points should be measured with a tape to guard against a dislocation of the wires during the day and for the purpose of having a measured base to check the wire interval in the morning. The ordinary diagram or slide rule can then be used to reduce the notes. Before having the adjustable hairs put in, a special diagram was used with a swinging graduated scale. In the morning and evening one distance was measured with a tape and checked with the rod to find the wire interval, and the swinging scale was made for the error discovered. The reason for the change in the wire interval is probably owing to the cement used to fasten the hairs in place. Other engineers have spoken to the writer about the alteration in the wire interval, and it may be a common experience.

When time is much of an object and the maps should be kept up as the work progresses, several books may be used for notes and one sent in with the man who brings out the lunch and the afternoon book left in the evening. Sometimes three or four books are used so the draftsman in camp can keep his work up. The writer has also used books with thin pages and had extra sheets of thin paper. One is placed under each page, with a sheet of carbon paper between. Thus the notes are copied through on the loose sheets, which are fastened together with clips and sent in to the draftsman from time to time or given to him each evening. It is a good idea also to do some sketching, and it is best done on the opposite page in a manner described in Engineering News some time ago. Several concentric circles are drawn with intervals of about 100 ft. or so, and the point in the center being used as the instrument station sketches are made fairly to scale and points plotted in their relative positions. With these sketches made on thin sheets having a sheet of carbon paper underneath and extra sheets to receive the impression, the sketches can also be sent in to the draftsman in camp. Using sketches together with the ordinary notes lessens the number of sights required and expedites the work both in the field and in the office.

The object of the writer in sending in this communication is to try and show the average engineer in private practice that it is not always necessary to have a large party to do a job expeditiously and do it well. The transit and stadia for the ordinary engineer and for the ordinary run of work is as good as any method yet devised, and the planetable and stadia method is only preferable under certain circumstances. That it is preferable and more rapid for the government or for large corporations having much topographical work to do, or for engineers making a specialty of such work and with a corps of low-paid, well-trained men always available, he is willing to admit, by reason of his experience with it.

Personally, however, he prefers transit and stadia methods. The notes are kept in a book and can be used whenever wanted, for maps can be drawn on any scale. The accuracy of each map is alike, for the error is simply that in reading the rod. The notes of the planetable method are plotted and the map is correct only for the scale on which plotted. A reduction in size of the map decreases errors proportionately, and an enlargement of the map increases the error proportionately.

As to the value of contour maps, there can no longer be any question. The method to adopt in making them for any particular locality or for any particular purpose depends upon local conditions. In using the planetable method on extensive surveys an educated engineer does not always make the best observer and observer's assistant. Any quick, intelligent man may be trained to the work in a short time, hence the reason for the low pay. The one big objection is that many of them imagine themselves to be good engineers after a season's work, which is not the best thing for the profession.

Ernest McCullough, City Engineer.

Lewiston, Idaho, March 22, 1902.

THE ROCKY MOUNTAIN COAL FIELDS, according to the 22d annual report of the U. S. Geological Survey, now in press, extends for 1,000 miles along the eastern base of the main range, from the Canadian boundary to and including New Mexico. Another less extensive belt occurs along the western base, in Wyoming, Utah, Colorado and New Mexico, with numerous isolated basins between these two main formations; these are all generally bituminous. There are also large areas of lignite, only valuable for local use, in Montana, Wyoming and the Dakotas. The latest estimates give a total area of 43,610 sq. miles for the anthracite, bituminous and lignitic-bituminous coal formations, and 56,500 sq. miles for the lignite. The Colorado coal fileds alone have been sufficiently worked to permit a fairly accurate estimate to be made of the character of these fields. Here the workable beds cover about 9,000 sq. miles, and the available coal is put down at 34,000 million tons. Beds containing from 22 to 106 ft. of clear coal are known, the coal varying from semi-bituminous to anthracite, with coke remarkably similar to the Connellsville coke. The New Mexico coal lies in beds from 3 to 6 ft. thick, and is a good coking coal. The Utah coal fields have been so little explored that the probable production area cannot be accurately estimated. That produced is nearly all semi-bituminous, with some coking coal found. The coal of North Dakota is lignitic, and disintegrates rapidly upon exposure; the same may be said of the coal of Eastern Montana and this region generally; except in Wyoming, there are no producing mines of any consequence. The Wyoming coal is of a lower grade, as a whole, than the mountain coal of Colorado and Montana. Workable beds 5 to 20 ft. thick are found; the coal is semi-bituminous, and good for steam and domestic use. No good coking coal nor workable anthracite has yet been found in Wyoming. In 1900, 277 commercial mines in North Dakota, Montana, Idaho, Wyoming, Utah, Colorado and New Mexico produced 13,496,555 short tons, valued at $17,400,000. Of this total 35% was used for railway fuel, 28% for manufacturing fuel, 27% for domestic fuel, and 9% was converted into coke.

THE MICHIGAN COAL FIELD, says the last annual report of the U. S. Geological Survey, now in press, covers an area of about 7,500 sq. miles. This coal is all bituminous, leaning to the gas-coal type; and as a steam coal it ranks with that of the Hocking Valley, but below Pocahontas coal. The total product in 1900 was 849,475 tons, valued at over $1,259,000. Saginaw and Bay counties produced nine-tenths of the output of 1900. The "Illinois" coal field occupies 35,000 sq. miles in Illinois, 6,500 sq. miles in southwestern Indiana and 4,500 sq. miles in western Kentucky. The workable coals of Illinois lie in beds from 3 to 10 ft. thick, often very near the surface. Most of these coals run high in gas and are not good coking coals; though the coke from Kentucky is of excellent quality. The product of this Eastern Interior Field, in 1900, was 35,000,000 short tons, valued at $36,200,000. Of this output over 31% was consumed by the railways, 34% as manufacturing fuel and 32% as domestic fuel.

PLANS TO CONTROL THE NICKEL PRODUCTION of the world have been carried through by the International Nickel Co., with Mr. Ambrose Monell as President, and Col. R. M. Thompson as Chairman of the Board of Directors. This company has, it is stated, secured control of the following companies: The Canadian Copper Co., in Canada and the United States; the Orford Copper Co., with extensive reduction works at Bayonne, N. J.; the Anglo-American Iron Co., and the Vermillion Manufacturing Co., in Canada; the American Nickel Works of Joseph Wharton, in Camden, N. J.; the Nickel Corporation, Limited, and the Societé Miniere Caledonienne in New Caledonia. The capital of the consolidating company consists of $10,000,000 of 5% bonds; $12,000,000 of preferred stock and $12,000,000 of common stock.

POWER PLANTS OF THE ST. LOUIS TRANSIT CO.

(With two-page plate.)

II.

NORTHERN POWER STATION.

This is an entirely new station, now nearly completed, and is situated near the river front, facing on Second and Salisbury Sts., with railway tracks on the east side, from which a siding has been laid for delivering coal. The main building covers half a city block, and north of this is the coal storage building, 185 ft. 10 ins. × 33 ft. 6 ins. In the main building the basement floor is level with the street, and here are located the condensers, wire conduits, piping, etc.; the height is 15 ft. from the basement floor to the second or boiler room floor. The engine room has a clear height of 45 ft. to the roof trusses. The floor space of the engine room is 19,305 sq. ft., while that of the engine and boiler rooms together is 28,610 sq. ft. The station has its own electric light plant, supplying current for incandescent arcs and ordinary incandescent lamps. It has a toilet room with modern sanitary plumbing for the closets, bath-tubs and wash-basins. Hot and cold water is supplied, and there are individual lockers for the use of the employees.

BUILDING.—The building is of self-sustaining steel skeleton construction with heavy walls of St. Louis brick, laid in cement; the floors are carried by concrete arches, and the roof is of cinder concrete covered with slate. A general view of the steel structure is given in Fig. 9, and shows the engine room on the left (with the traveling crane and the concrete engine foundations) and the boiler room (with its coal bins) on the right. About 1,270 tons of steel are used in the framework and trusses. The building is erected on bad ground, consisting largely of quicksand, and is therefore built on pile foundations. There are 2,400 white oak piles, with 10-in. points, driven to the rock, at a depth of 35 to 40 ft. below the surface. On these are the concrete foundations for the steel frame, the seven engines, other machinery and the smokestack, aggregating 315,000 cu. ft. of concrete, all made with Lehigh Portland cement. An idea of the size of these foundation blocks may be gathered from the view in Fig. 10. The concrete foundations, floors, fireproofing and roof were built by the Gilsonite Construction Co., of St. Louis. The general construction of building and arrangement of the machinery are shown in the cross section, Fig. 11.

The floors are of concrete arches, of 36 ins. to 60 ins. span between the I-beams, with 6 ins. crown. The beams are mainly 15 ins. deep, the floor girders consisting of pairs of these I-beams. The concrete is covered with a granitoid floor.

The engine room has white enameled brick wainscoting to a height of about 7 ft., finished with an oak molding. Above this the walls are finished with Keene's cement plaster, scribed off to imitate stone work. The roof trusses and roof are painted white. All piping is laid under the floor. The roof is of monolithic slabs of cinder concrete, 4 ins. thick, built in place, and reinforced by steel bars extending between the purlins and embedded in the concrete. This concrete is covered with tarred paper and Brownsville slate, the slate being nailed directly to the concrete.

In the boiler room, a gallery consisting of an iron grating gives easy access to the steam headers, the feed water purifiers and other apparatus, while iron stairways lead to the gallery and to the cooling tower platform on the roof. These greatly facilitate inspection and repairs, while the grating construction causes little interference to light or ventilation. The platform of the steam headers is supported by wall brackets, with hangers from the roof trusses to the outer edge of the platform, as shown in Fig. 11.

The basement columns supporting the boiler room floor are of cast iron. The main columns of the boiler room are composed of four 5-in. Z-bars, forming two channel shaped vertical chords connected by a web of lacing bars. The coal bin columns are of box section, with a cen-

tral web or diaphragm, and are built up as follows: Four 6-in. Z-bars, 1 web plate, $\frac{3}{8} \times 8$ ins., and 2 cover plates, $\frac{3}{8} \times 14\frac{1}{2}$ ins., 52 ft. $4\frac{1}{2}$ ins. long. The columns of the engine room are of special construction, having to carry the 75-ton traveling cranes. There are three vertical members, each composed of a pair of 5-in. Z-bars. Two of these members extend the full height of the building and are $12\frac{7}{8}$ ins. apart, built into the wall. The third member extends only to the plate girder crane runway and is $19\frac{1}{8}$ ins. from the middle member. The three members are connected by horizontal angle iron ties riveted across the outer flanges, and by a web system of double lattice bars riveted between the inner flanges of the three members. The column construction is shown separately in Fig. 11. Between the columns are horizontal longitudinal struts, and vertical diagonal bracing is used in some of the panels. The heads of the columns are connected by longitudinal lattice girders $31\frac{1}{2}$ ins. deep. The lintels are formed of sets of three 15-in. channels. The roof trusses are triangular, 66 ft. $8\frac{1}{2}$ ins. span, and 20 ft. high, with a monitor roof, as shown in Fig 11. The crane girders are 42 ins. deep, with four flange angles 6×6 ins., and a $\frac{3}{8}$-in. web. In the boiler room, the coal bins are supported by 48-in. plate girders. The bins are of $\frac{3}{8}$-in. plate, stiffened by angle iron belts and corners.

Wabash R.R.
St. L. K. & N.W.
Broadway
CABARET ISL.
Wabash R.R.
Florissant Ave.
Cem. Calvary
Belle fontaine Cemetery
Chi. & Alton Wabash R.R. Terminal
Merchants Bridge
KERR ISL.
City Limits
St. L. Terminal Ry.
O'Fallon Park
Natural Bridge Road
Fair Grounds Ave.
NORTHERN POWER STATION
N. Market St.
Salisbury St.
Palm St.
Delmar
Kingshighway
St. L. K. C. & Col. R'y
Lindell Ave.
Grand Ave.
Cass Ave.
Franklin Ave.
Olive St.
Forest Park (World's Fair, 1903)
South Ave.
UNION RY. STATION
Market St.
EAST SIDE
EAST SIDE R.R.
EAST SIDE
EAST SIDE
EAST SIDE

revolutions. The towers are supported on a platform between the engine room and boiler room roofs, and supported by the roof trusses, as shown in Fig. 11. In view of the fact that they are thus carried by the trusses, it was not considered advisable to operate the fans by steam engines, on account of the vibration that would be set up, although the engines would have the advantage of enabling the speed of the fans to be regulated to adjust the air currents very closely to the requirements due to atmospheric conditions. The two fans of each tower are driven by endless rope transmission from a variable-speed 550-volt electric motor, which may be run at 125, 200 or 250 revolutions per minute. One-half of the condensing and cooling plant is shown in Fig. 13.

BOILERS.—In the boiler room is a single row of 16 O'Brien water-tube boilers of 400 HP. each, based on a rating of 30 lbs. of coal consumed per sq. ft. of grate surface per hour. The boilers have the Green chain grates, 9 ft. 8 ins. wide and 9 ft. long, operated by four Krieble engines. On a gallery above the boilers are eight Hoppes feed-water purifiers, each 68 ins. diameter, 26 ft. long, with 1,759 sq. ft. of lime collecting surface, and rated at 1,000 HP. These supply the water by gravity to the boilers, taking the water from the four Excelsior feed-water heaters, capable of heating 63,000 lbs. of water per hour, from 110° to

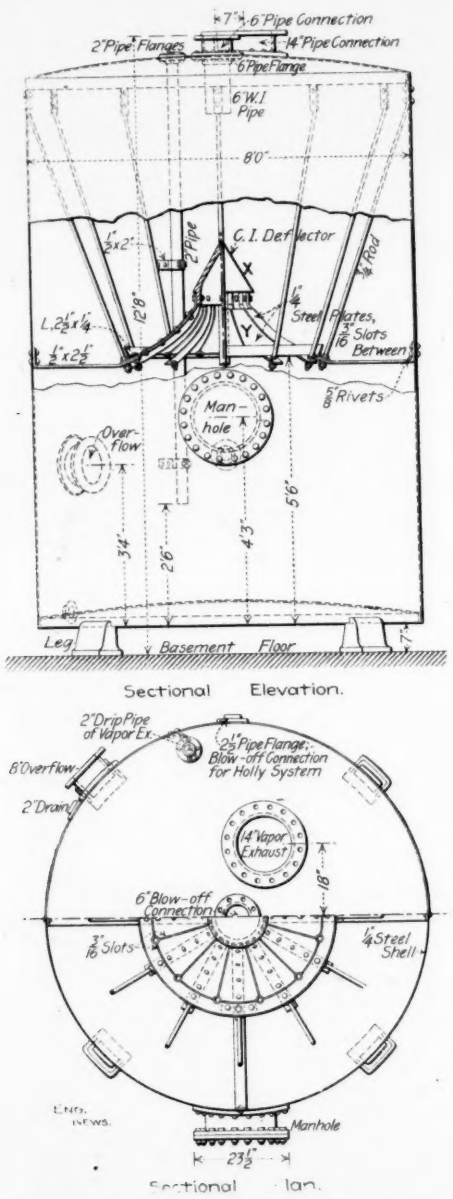


Fig. 15. Blow-Off Tank.

206° or 211°; the four heaters take 20,000 lbs. of exhaust steam per hour. If the feed is delivered to the heaters at atmospheric temperature they will require 40,000 lbs. of steam per hour. The heaters are 5 ft. diameter, 14 ft. 6 ins. high, and each has a by-pass so that it can be cut out of service. There are three boiler feed pumps, built by the Epping-Carpenter Co., of Pittsburg, having cylinders 12×8½×12 ins.; also a pressure pump and a circulating pump of the same make and size, the latter driving the turbine-flue cleaners used on the boilers.

The smoke flues lead to a steel chimney 14 ft. diameter and 202 ft. high, on a concrete foundation 30 ft. square extending to the solid rock, 47 ft. below the base of the chimney. This foundation has tunnel leading to a central chamber, by

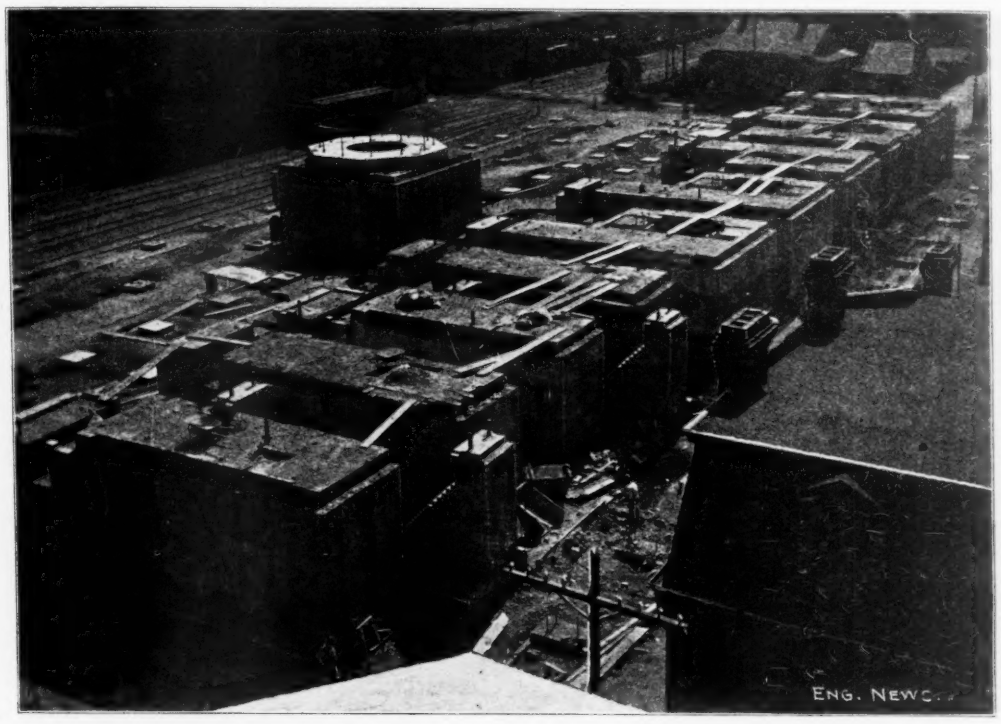


FIG. 10. CONCRETE FOUNDATIONS FOR ENGINES AND CHIMNEY.

which the interior of the chimney is made accessible. This chimney is identical in design with the one at the Central power station, and was described in our issue of Dec. 19, 1901.

METERS AND MISCELLANEOUS EQUIPMENT.—The water supply is taken partly from deep wells in the station and partly from the city mains, the local ordinances forbidding the taking of water direct from the river. Hence it is necessary to save as much water as possible by condensing. The water supply from the mains and to the boilers is all metered by Hersey disk meters. In the street are two 4-in. meters for measuring the supply from the mains. In the station are three 4-in. hot-water meters and one 6-in. cold-water meter. A tank 16×24 ft. holds a supply of 49,700 gallons for emergency supply and for fire protection.

Each engine has a 12-in. Cochrane live-steam receiver-separator, and all the main and auxiliary engines are lubricated by distribution from a central table by the Siegrist automatic oiling system, which is provided with two Famous filters having a capacity for filtering 600 gallons of oil in 24 hours. The piping is of extra heavy pipe with Crane valves, as in the Central station, but all large valves over 30 ins. diameter are of the Kennedy make. Bends instead of elbows are used wherever possible. The pipe, heaters, etc., are covered with the H. W. Johns-Melville Co.'s asbestos sponge-felt covering. The plan of the steam and exhaust piping is shown in Fig. 12. The 20-in. main steam header is supported by saddles on roller bearings, and is secured to the saddles by straps of ⅜-in. rods. Each saddle has two chilled bearing surfaces resting on the ends of a single roller 2 ins. diameter and 10 ins. long, which in turn rests in two babbeted bearings in the base plate. The roller has no travel, but revolves in its bearings. This construction is shown in Fig. 14.

From the hot well or the city mains the feed water is piped to the heaters, going thence to the Hoppes purifiers, and thence to the boilers. The steam is taken from the drum of the boiler by a 10-in. vertical pipe, connecting with a 12-in. pipe and 14-in. steel bend opening into a steam header 14 to 20 ins. diameter, from which 12-in. pipes run to the high-pressure cylinders of the engines. The low-pressure exhaust is taken by 12-in. and 14-in. pipes to an exhaust header 24 to 30 ins. diameter, from which 36-in. pipes lead to the condensers, gate-valves and oil separators being interposed between the header and condenser. There is also a 30-in. free exhaust connection.

When steam is blown off from the boilers, it is discharged into a tank of special construction, designed to prevent the surging and disturbance which usually takes place when steam is blown off into a tank half full of water. The tank, Fig. 15, is 8 ft. diameter and about 12 ft. high, with a 6-in. blow-off pipe entering the top, and a 14-in. relief pipe also attached to the top. At about 5 ft. 6 ins. from the bottom is a deflecting cone, with a solid top and flaring wings or blades, supported by sling stays from the top and braces at the side. The entering steam, instead of blowing directly against the solid body of water (about 3 ft. deep) and raising it violently in the relief pipe, is deflected and broken up by the cone.

COAL AND ASHES.—The coal storage building, Fig. 16, is separated from the main building

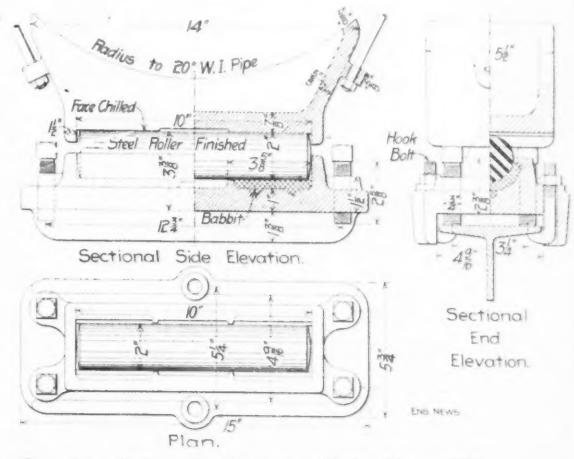
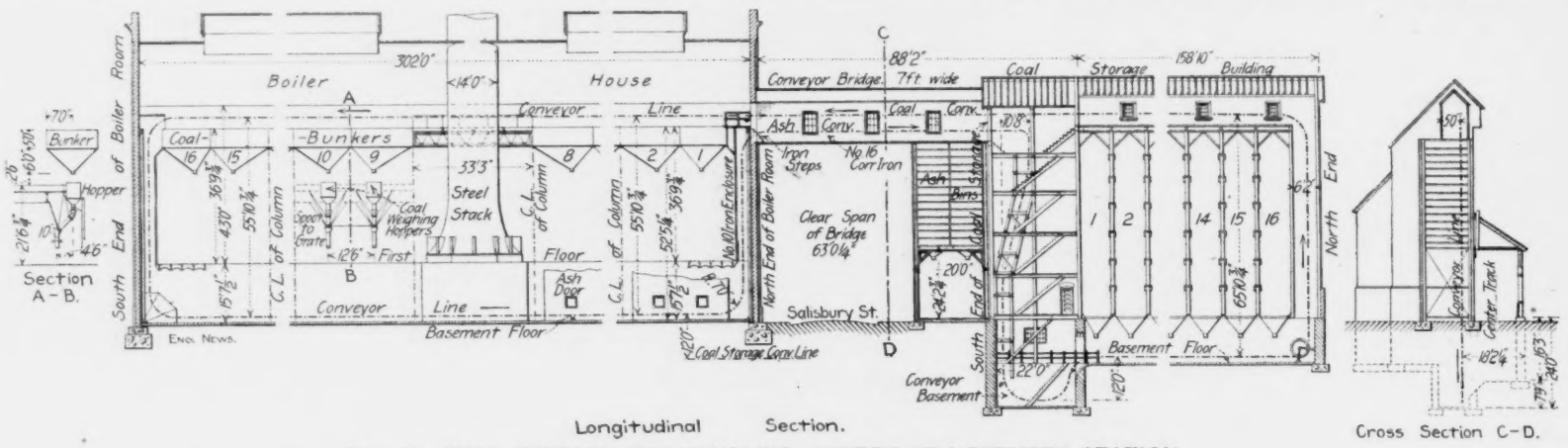


Fig. 14. Roller Bearings for Main Steam Pipe Carrier.

by a street, and is of timber construction, supported by piles driven to rock, the site being over a quicksand pocket. The coal from the conveyor buckets falls upon an inclined screen, as shown in the section, Fig. 17. This screen, consisting of iron bars ½-in. wide and ¾-in. apart, allows the dust and fine stuff to fall directly to the bottom of the bin, where it will be drawn off promptly. Ventilation is provided for by box ventilators, as in the coal storage buildings of the Central station. This building has a storage capacity of 3,500 tons, and is equipped with a coal crushing

plant which will crush 40 to 45 tons of run-of-mine coal per hour, to a size of 1½-in. cube. Outside the building is a side track, with a Fairbanks & Morse 80-ton track scale for weighing the coal cars. Coal from the cars is shoveled or dumped into a pit under the tracks, from which it is delivered to the crusher and then to the conveyor.

A conveyor of the McCaslin type, built by the John A. Mead Mfg. Co., of New York, handles both the coal and ashes. The conveyor and the crusher are driven by steam. Above each boiler is a steel bunker holding sufficient coal for 12 hours' run. Under the bunker is a weighing hopper of 2 tons capacity, fitted with a Howe recording scale, which shows the amount of coal delivered from the bunker to each boiler. The hoppers feeds directly to the grates. Separate ash conveyors will be installed for emptying the ash pits directly into the main conveyor, which carries the ashes across the bridge and deposits them in an elevated ash bin in front of the storage building. Provision is made for loading the conveyor with coal shoveled direct from the cars into four chutes at the side of the boiler room, instead of taking it from the storage building. The construction of the storage building and arrangement of the conveyor plant are shown in Figs. 16 and 17.



Longitudinal Section.

FIG. 16. COAL STORAGE AND HANDLING SYSTEM AT NORTHERN STATION.

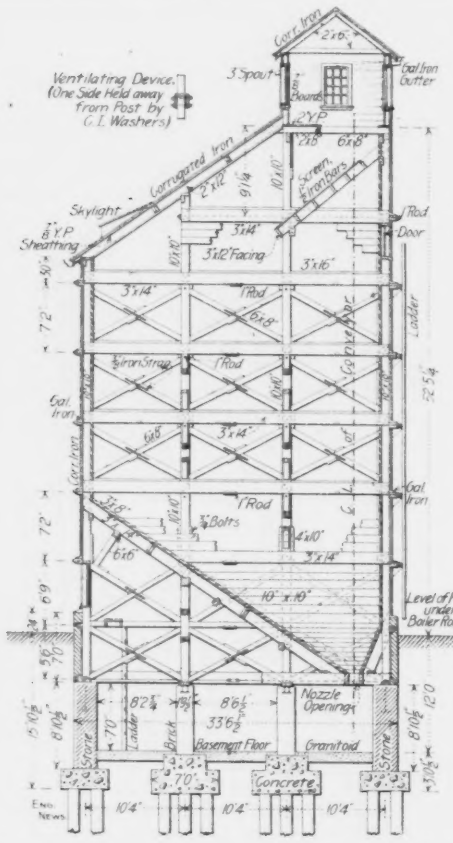


Fig. 17. Cross-Section of Coal Storage Building.

SUBSTATION.

Operated in connection with the Northern power station is Substation No. 1, at Delmar and De Balivere Aves. This is a brick fireproof building, Fig. 18. It is about 115 ft. × 45 ft., and 35 ft. high from the floor to the roof trusses. Provision is made for extending the building to a length of 230 ft. For handling machinery, etc, there is a Case electric traveling crane of 45 ft. span, and a hoist of 20 ft. 6 ins. The speeds are the same as in the larger cranes in the main stations, already described. The runways consist of 18-in. I-beams, with anchored attachments on the abutments supporting the beams, and also supported by braces attached to anchor rods passing through the walls.

One side of the building is set apart for high-tension cables and apparatus, and the other side for low tension. The electric equipment is of the General Electric Co.'s make, and its arrangement is shown in Fig. 19. There are four 8-pole, 600-K-W., 600-volt converters, running at 375 revolutions. These occupy a floor space of 10 ft. × 9 ft. 2 ins., and weigh 45,000 lbs. each. There are also four reactances. The transformer equipment comprises 13 air blast, 25-cycle, 250-K-W., 380-volt transformers, 47 × 38 ins., 75 ins. high, weighing 7,700 lbs. each. These are cooled by two Buffalo blowers, directly connected to two 8-pole, 600-volt motors of 3 HP., at 275 revolutions. There is also a 25-cycle, 25-K-W. three-phase transformer of 6,000 to 350 volts. The starting set is a 4-pole, 20-K-W., 550-volt generator, directly connected to a 4-pole, 30-HP., 350-volt induction motor. These are mounted on the same base and run at 750 revolutions. There is also a Westinghouse 350-K-W. booster of the engine type, with 8-pole generator and 6-pole motor, running at 425 revolutions. This is connected to the 550-volt circuit. A duplicate of this machine is to be installed later. The main switchboard has 21 panels; 2 line panels for the high tension feeders, 4 alternating current panels for the rotary converters, 4 direct-current feeder panels, 10 21,000-ampere direct-current feeder panels and 1 panel for the starting set. There is also an auxiliary switchboard for the booster.

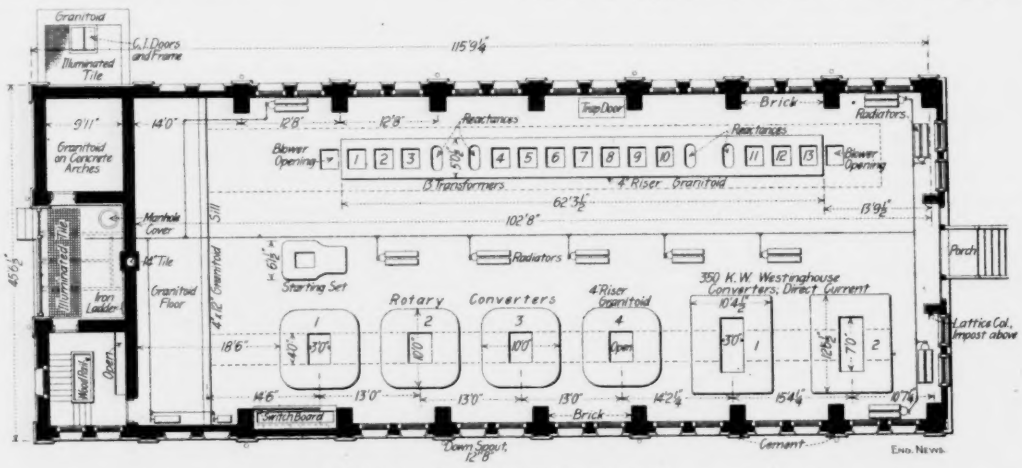


FIG. 19. PLAN OF SUBSTATION.

ENGINEERS AND CONTRACTORS.

The entire designing of these stations was done by the W. D. Boyce Engineering Co., Chemical Building, St. Louis, Mo., which company also had sole charge of their construction, being the Consulting and Supervising Engineers for the St. Louis Transit Co. The members of the W. D. Boyce Engineering Co. are W. D. Boyce, President; W. R. Macklind, Vice-President, who did the designing work (they being the engineers of the company); and W. W. Stroop, Secretary and Treasurer, having charge of the office department. In the execution of the above work, Mr. R. E. Gurley had charge of the construction department; assisted by Mr. W. S. Ludington, at the Central Station, and the substation; and Mr. O. E. Overpeck at the Northern Station.

The contractors were as follows: Central Station: Masonry, brick, carpenter work, etc., Jacob Schenck and Samuel Hoffman; steel work, Pittsburg Bridge Co., Pittsburg, Pa., and Union Bridge Co., Atheas, Pa.; coal storage buildings, R. W.

Fig. 18. Substation; St. Louis Transit Co.

Morrison Construction Co. and E. A. Steininger, of St. Louis. Northern Station: Masonry, brick, carpenter work, etc., A. H. Hasseler, St. Louis; steel work, Union Bridge Co., Athens, Pa.; coal storage building, J. D. Fitzgibbon. Substation: E. A. Steininger. All cast-iron work for both stations was supplied by the Koken Iron Works, St. Louis, Mo., and all the pipe work was done by S. J. McLeod, of Chicago. The two 202-ft. steel smokestacks were built by the O'Brien Boiler Works, of St. Louis. The builders of the engines, dynamos, boilers and other parts of the mechanical and electrical equipment have been mentioned in other parts of this article.

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